K665 O38p

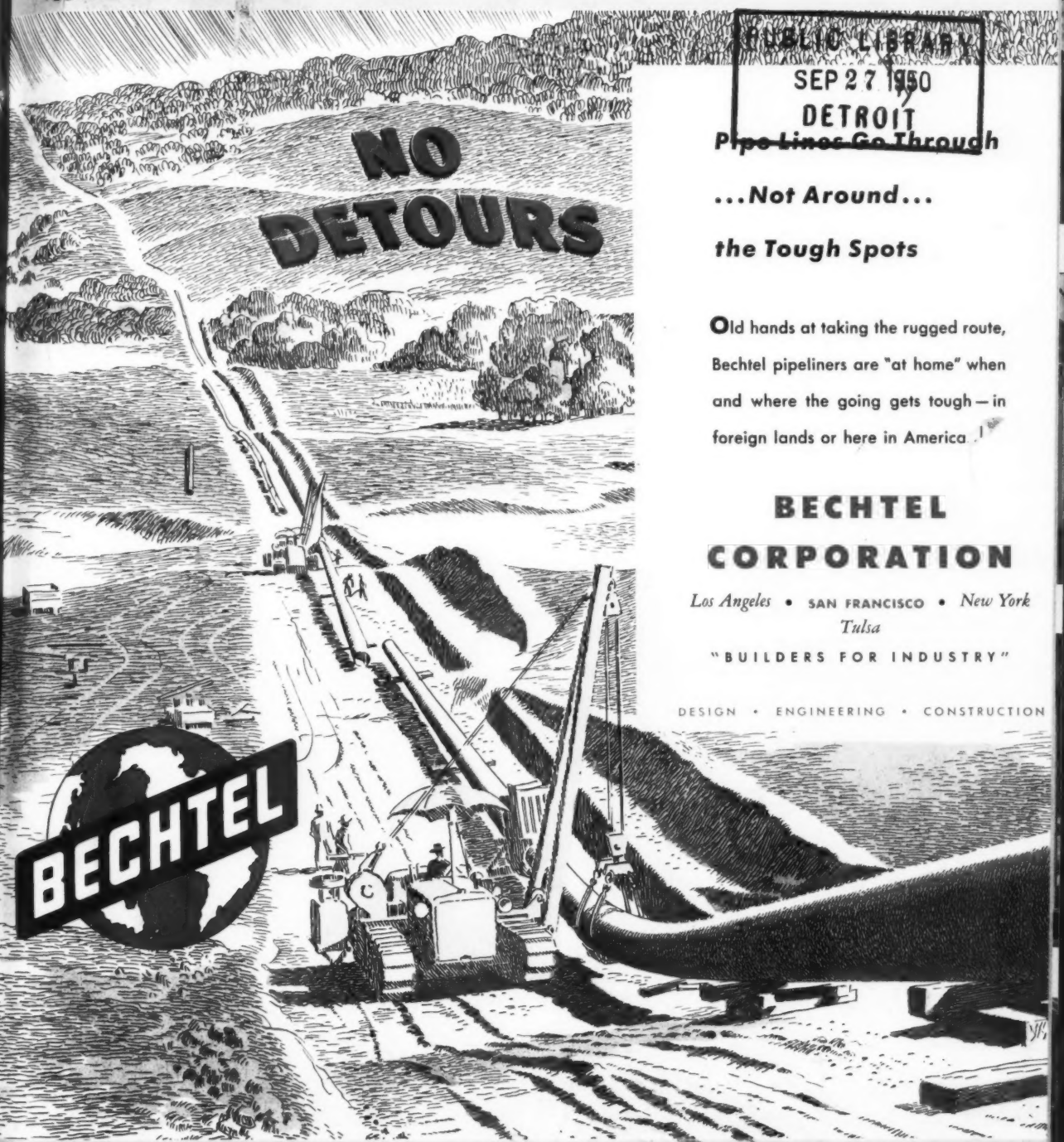
ANNUAL
PIPE-LINE
NUMBER

WITH INSERT MAPS OF
• Crude-Oil and Product Lines
• Natural-Gas Lines

L AND GAS JURNAL

TECHNOLOGY DEPT.

PUBLIC LIBRARY
SEP 27 1950
DETROIT



~~Pipe Lines Go Through~~

...Not Around...

the Tough Spots

Old hands at taking the rugged route, Bechtel pipeliners are "at home" when and where the going gets tough—in foreign lands or here in America.

BECHTEL CORPORATION

Los Angeles • SAN FRANCISCO • *New York*
Tulsa

"BUILDERS FOR INDUSTRY"

DESIGN • ENGINEERING • CONSTRUCTION

PRICE 50 CENTS TABLE OF CONTENTS PAGE 165 **SEPTEMBER 21, 1950**

XUM

You use hard-faced rock bits

for endurance...

then *also* use hard-faced Mud Valves

for *greater* endurance

MERCHROME-COATED PLUG VALVE
(BEFORE MACHINING)

You know by experience that any rock bit lasts far longer when *hard-faced*. So it is with mud line valves. Nordstrom Merchrome coated mud line valves are hard-faced to file-hardness. Then the plug and body seat are ground to precision fit and lapped. The seat is *never* exposed. Automatic lubrication with Hypermatic further insures against abrasion and leakage. The ports are pressure-sealed with energized lubricant.

Abrasion is barred from getting a start. Merchrome coating adds tens of thousands of feet in extra drilling life to your valves. The cost of a Nordstrom mud line valve is a fraction of usual cost if you figure the amount of hole drilled per valve.

MERCHROME-COATED . . .

Nordstrom Valves

Nordstrom Valve Division — ROCKWELL MANUFACTURING COMPANY

400 North Lexington Avenue • Pittsburgh 8, Pennsylvania

Atlanta, Boston, Chicago, Columbus, Houston, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco, Seattle, Tulsa
... and leading Supply Houses • Export: Rockwell Manufacturing Co., International Division, 7701 Empire State Building, New York 1, N. Y.

FOR GREATER STABILITY AT HIGH OPERATING TEMPERATURES

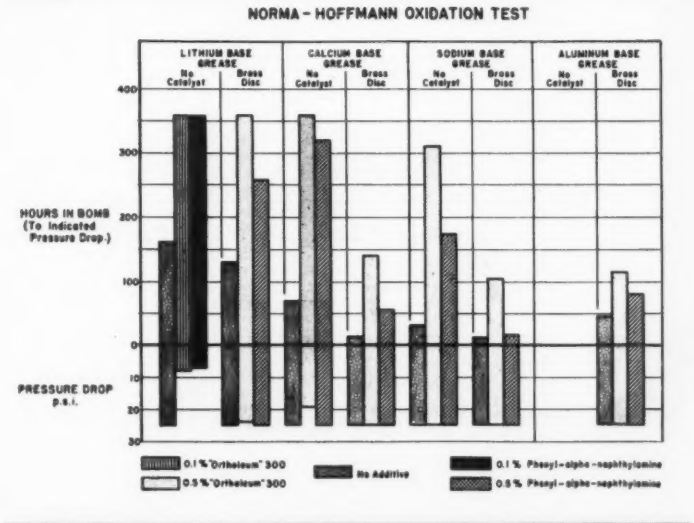
USE DU PONT "ORTHOLEUM" 300 GREASE STABILIZER

The high temperature and high pressure demands put upon greases by modern equipment brings a definite need for greater thermal stability and resistance to oxidation—a quality demand that is passed on to the refiner.

"Ortholeum" 300 Grease Stabilizer has been developed to meet this need. This new additive combines both antioxidant and metal deactivating properties, and the combination imparts oxidation stability to the grease, superior to that attainable with antioxidants alone. In addition, it does not cause discoloration of the finished product.

"Ortholeum" 300 has been evaluated in many types of greases and the Norma-Hoffmann Oxidation Test shows markedly greater effectiveness over compounds such as Phenyl-alpha-naphthylamine. While effective in a non-catalyzed system, its advantages are most marked in a catalyzed system. Test results on several types of greases are shown opposite.

Samples can be obtained for evaluation in your own greases from the nearest Du Pont District Office or from your Du Pont Petroleum Chemicals Representative. For more complete information, ask for Technical Bulletin GS-50.



PHYSICAL PROPERTIES

Appearance	Brown flakes
Melting Range, °F.	
Starts to melt	125
Completely melted	160
Normal Use Concentrations Wt. %	0.2 to 1.0
Miscibility with oils and greases	In all proportions above 160°F. Normal use concentrations soluble at all temperatures.

DU PONT
REG. U. S. PAT. OFF.

Better Things for Better Living
. . . through Chemistry

Petroleum Chemicals

Make Du Pont the Source for All of Your Gasoline Additives . . . Tetraethyl Lead Compounds (Motor Mix—Aviation Mix)—Antioxidants—Metal Deactivator—Dyes

E. I. DU PONT DE NEMOURS & COMPANY (INC.)
Petroleum Chemicals Division • Wilmington 98, Delaware

District Offices: New York, N. Y. · Chicago, Ill. · Tulsa, Okla. · Houston, Texas · Los Angeles, Calif.

District Laboratories: Wilmington, Del. · Chicago, Ill. · Tulsa, Okla. · Houston, Texas · El Monte, Calif.

The Oil and Gas Journal, published Thursdays by The Petroleum Publishing Company. Entered as second-class matter September 1, 1910, at post office at Tulsa, Okla., under act of March 3, 1879. U. S. and foreign rates to the petroleum industry, $3 yearly. Copyright 1950.

XUM

. . . does your motor do this?

● Does it give you the best possible operation under any permissible voltage variation . . . give you the most for its type, in handling heavy starting loads . . . take long period, peak capacity operation? The Fairbanks-Morse QZK Motor, with its indestructible Copperspun Rotor, does!

Does it stand up under falling particles and dripping liquids? The Fairbanks-Morse QZK, with its unique, one-piece cast frame that protects the motor in any position, does!

Does it operate at a uniform cool temperature? The Fairbanks-Morse QZK, with its efficient cross-flow ventilation, does!

Does it have bearings that show little signs of wear . . . that never burn out and seize shafts? The QZK, with its cartridge type ball bearing mountings, does!

If your motor does not have these advantages, better see your supply store about Fairbanks-Morse Motors for long, economical efficient service. Fairbanks, Morse & Co., Chicago 5, Ill.

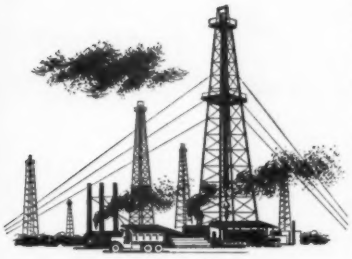
FAIRBANKS-MORSE,

a name worth remembering

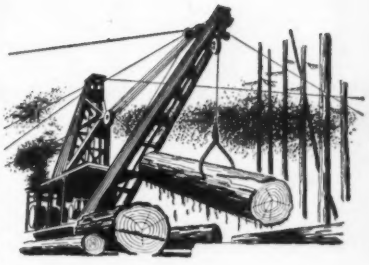
OIL FIELD EQUIPMENT • DIESEL LOCOMOTIVES AND ENGINES • ELECTRICAL MACHINERY
PUMPS • SCALES • HOME WATER SERVICE AND HEATING EQUIPMENT • RAIL CARS
FARM MACHINERY

The exclusive Copperspun Rotor is truly indestructible—under any type of operating condition.

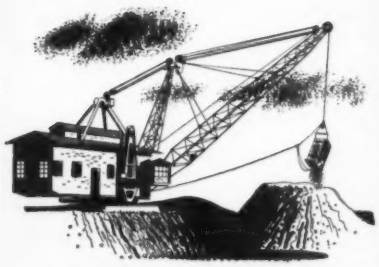
For better service use the right rope



For rotary drilling, *PRE*formed, Internally Lubricated wire line designed to wind smoothly on drums and to withstand abrasion from running through blocks.

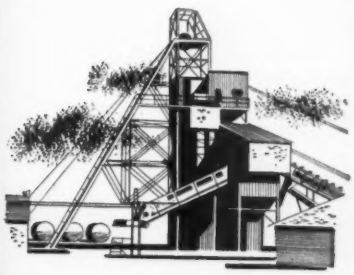


For logging operations, tough flexible ropes for tractor arch lines, chokers, skidders and loading.

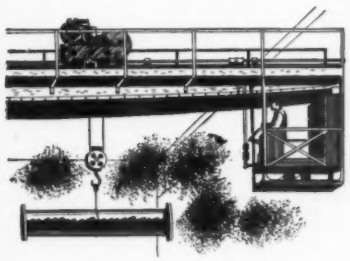


For shovels and draglines, ropes for different sizes and types of equipment designed to give best service for your particular needs.

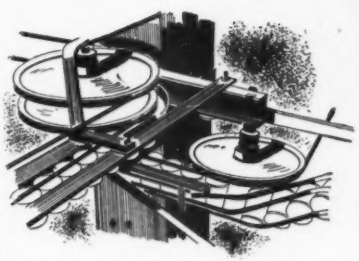
The right rope for each job is available from



For shaft mining, shallow or deep, internally lubricated ropes to meet all load and speed requirements.



For cranes and hoists, small or large, *PRE*formed Internally Lubricated wire ropes of the correct size and flexibility for each use.



For can conveyors, there are bright carbon steel, stainless steel and monel metal wire ropes to meet various service conditions.

A thousand and one
MACWHYTE
Internally Lubricated
WIRE ROPES

It pays to choose the right rope for your equipment

Besides the ropes listed above, Macwhyte makes many more such as cable tool drilling lines, elevator cables, incline or haulage ropes, scraper ropes, aircraft control cable assemblies, ropes for ship rigging and guying work, as well as hundreds of sizes and types of single-part, round-braided or flat-braided slings for material handling.

To get the best service, keep down maintenance costs, and *save wire rope dollars,* call your Macwhyte distributor or write direct to Macwhyte Company for recommendations. Catalog on request.

MACWHYTE WIRE ROPE

MACWHYTE COMPANY 2910 Fourteenth Avenue, Kenosha, Wisconsin Manufacturers of Internally Lubricated PREformed Wire Rope, Braided Wire Rope Slings, Aircraft Cables and Assemblies, Monel Metal and Stainless Steel Wire Rope. Our distributors and mill depots carry stocks for immediate delivery. Mill Depots: New York • Pittsburgh • Chicago Minneapolis • Fort Worth • Portland • Seattle • San Francisco • Los Angeles

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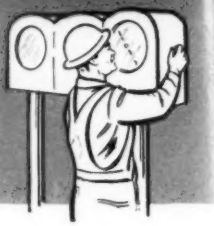
XUM

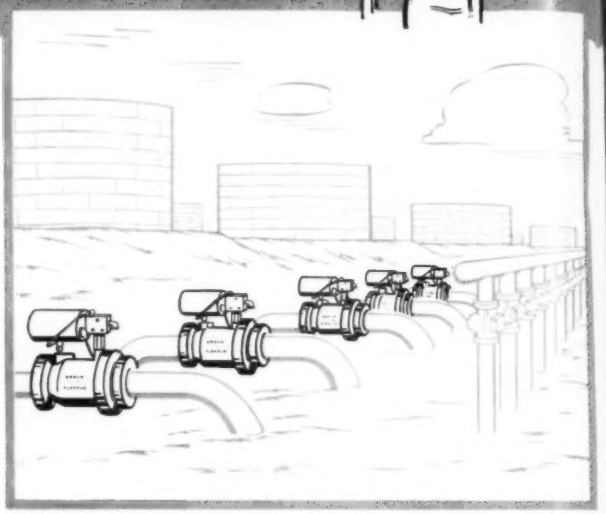
GROVE REMOTE CONTROL

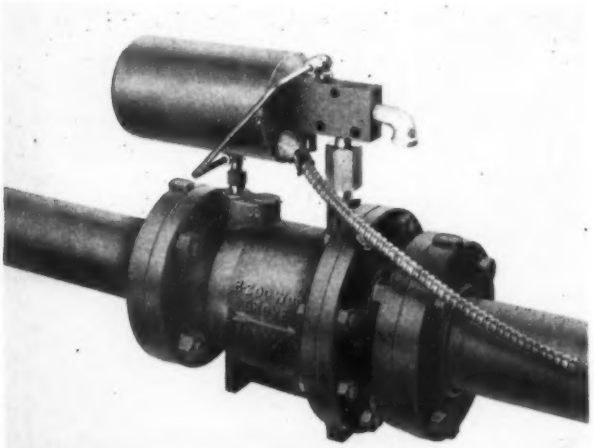


SOLENOID OPERATED *flexflo* VALVES

Electrical operation of the Grove FlexFlo is the practical, dependable solution to your remote control requirements. No motors or complicated wiring are necessary. The pressure in the line does the work, opening the FlexFlo with a smooth, rolling action, or closing it with a bubble-tight seal.

The Solenoid Pilot, mounted on the valve, is controlled from a remote panel. This Pilot uses the actual line pressure to open or close the FlexFlo. In this way the Grove FlexFlo Remote Control Valve can be operated as surely and easily as if the operator were at the valve.

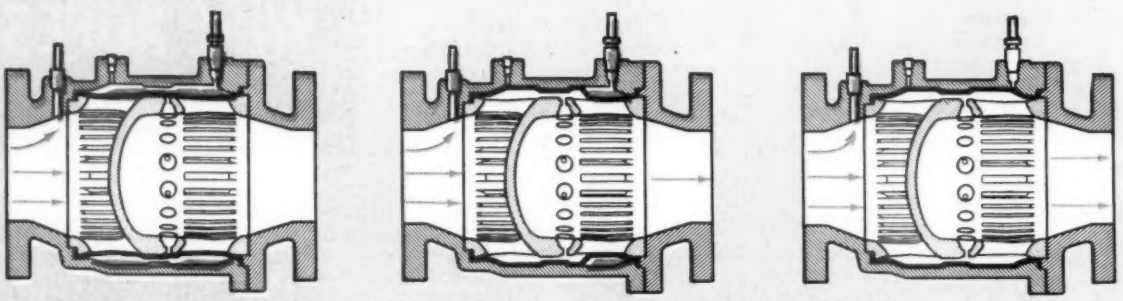




The simple FlexFlo design has been proved in more than ten years of hard service to be unequalled for dependability and long, trouble-free life in the control of air, gas, oil, water, and salt water at temperatures to 150° F. and at pressures to 1500 p.s.i.

Let the Grove FlexFlo engineer show how this dependable remote control valve will increase the efficiency of your plant's operations. Write for full information.

flexflo LETS PRESSURE DO THE WORK



The only moving part in the Grove FlexFlo is a tough Buna N tube, which fits closely around a slotted metal core. When closed, line pressure from within, tending to force the tube off the core, is opposed by equal line pressure on the outside of the tube. Equalizing the inner and outer pressure allows the elasticity of the tube to grip tightly around the core with a positive, sealing action.

As the control pilot closes off line pressure acting on the outside of the tube, inner line pressure, being greater than the outer, begins to roll the tube off the core, opening the FlexFlo.

When pressure on the outer side of the tube is entirely removed, the inner pressure forces the tube completely off the slotted core, opening the valve wide and permitting free flow.

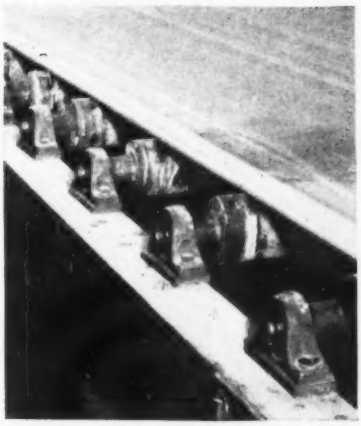
GROVE REGULATOR COMPANY

1901 CALUMET ST., HOUSTON 4, TEXAS • 6529 HOLLIS ST., OAKLAND, CALIF. • 1930 W. OLYMPIC BLVD., LOS ANGELES, CALIF.

XUM

install LINK-BELT Ball and Roller Bearings and...

let 'em roll...



They are pre-lubricated

All Link-Belt solid housing bearing blocks are pre-lubricated with high-grade lubricant at assembly, and are ready for operation.

They have a large grease reservoir

Re-lubrication is necessary only at long intervals. The large grease reservoir, sealed against lubricant loss and dirt entry, contributes to long life and efficiency.

They have protection against over lubrication

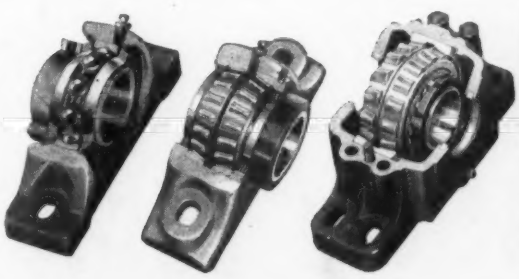
Each solid housing block is equipped with a pressure relief grease fitting to avoid damaging pressures.

We invite you to discuss your ball and roller bearing requirements with an experienced Link-Belt Bearing Engineer. May we send Data Book No. 2550?

LINK-BELT COMPANY Indianapolis 6, Chicago 9, Philadelphia 40, Atlanta, Minneapolis 5, Houston 1, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Johannesburg. Offices, Factory Branch Stores and Distributors in Principal Cities.

11,801

A complete line of bearings is available from stock, throughout the country, in pillow blocks, cartridge, flanged cartridge, flanged, hanger and takeup blocks —also unmounted bearings.



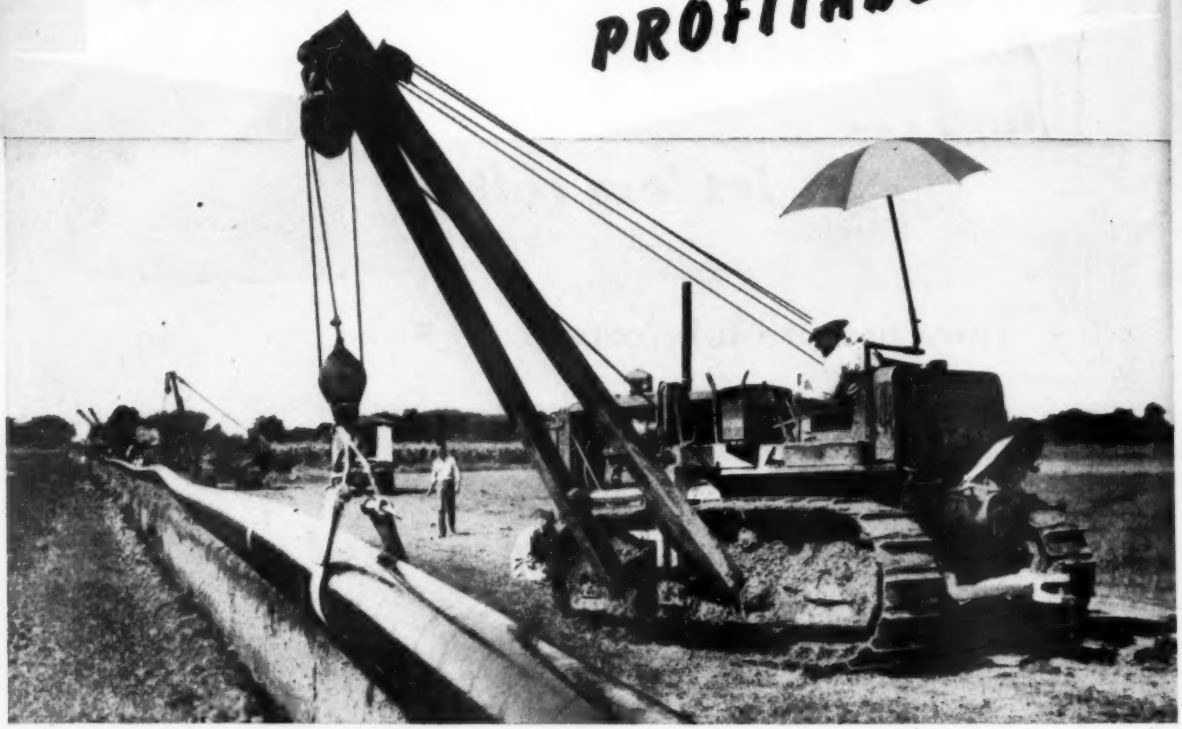
LINK-BELT

BALL & ROLLER

BEARINGS

TRACKSON PIPE LAYERS

KEEP PIPELINE CONTRACTS PROFITABLE!



TRACKSON PIPE LAYERS have every modern operating feature to keep your pipe line contracts in the profit class!

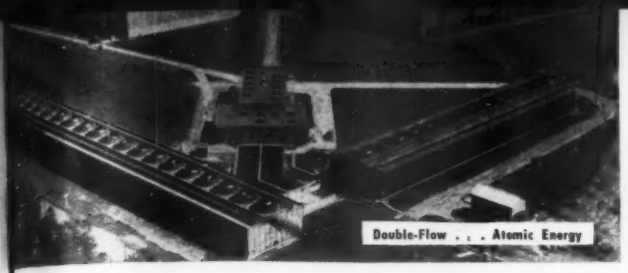
Years of experience in building and designing pipe line equipment have given these all-round Pipe Liner's tools more work capacity and an ability to work years longer!

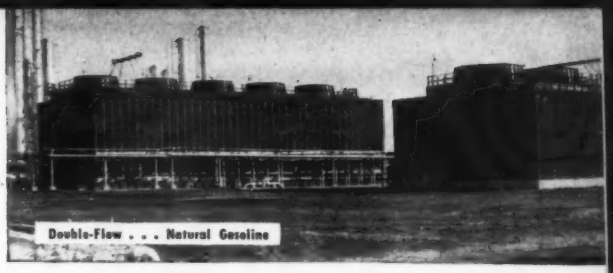
TRACKSON PIPE LAYERS transmit power through heavy-duty, time-tested transmissions designed and produced by TRACKSON COMPANY. Frames and booms are built of heavy steel plate and structurals, fabricated into sturdy unit components by master steel workers, welders and machinists. Quality construction of these rugged machines readies them for long hours of punishing pipe line work without rest — to you this means Profitable Operation.

All controls are within easy reach of the seated operator, and "spring-loaded" drum brakes provide top safety and accuracy of control. Ease of operation — perfect control on lifts from lightest to heaviest — fast and safe working on all phases of the job — all spell high production at low cost for maximum profits with TRACKSON PIPE LAYERS.

There are five job-proved models — each matched to the size and power of a "Caterpillar" Diesel Tractor — to give you the tools for handling everything from "Super-Inch" mainline pipe to small feeder pipe. For complete information call or visit your nearby TRACKSON-"Caterpillar" Dealer today, or write to TRACKSON COMPANY, Dept. OG-90, Milwaukee 1, Wisconsin.

TRACKSON TRACTOR EQUIPMENT


Double-Flow . . . Atomic Energy

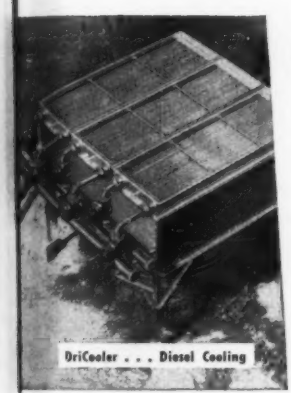

Double-Flow . . . Natural Gasoline

WHAT IS YOUR COOLING PROBLEM?

Spray Pond . . . Refinery

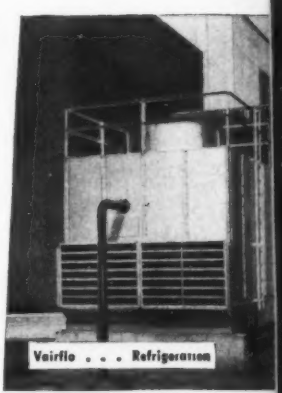
Conventional . . . Pipe Line

IS IT COST? Cooling towers or DriCoolers can have a low first cost with higher operating cost and vice versa. Or, you can get an economical combination of both. Marley application engineers have a complete line of units to select from and the "know-how" to help you make the best selection for your purpose.


DriCooler . . . Diesel Cooling

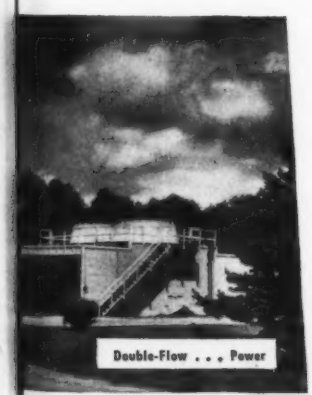
IS IT SPACE? Marley equipment may be installed indoors or outdoors. Units are available with large base area and low height to give light loading per square foot or with small base area and greater height to fit in small area.

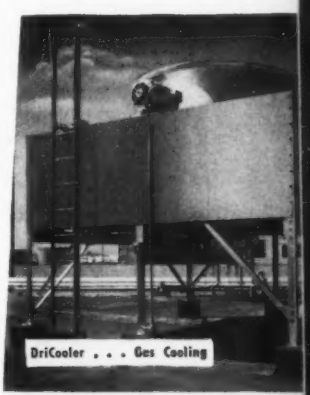
IS IT TEMPERATURE? Usually, it is not economical to cool lower than a 5F approach to the wet bulb. However, in Marley cross-flow towers a quantity of water at wet bulb temperature may be obtained without added cost. For high level cooling, the DriCooler is applicable.


Vairflo . . . Refrigeration

IS IT LOCATION? Extreme temperatures, cold or hot, dust, wet bulb, altitude, brackish water, wind, storm conditions, or lack of proper water supply are problems that must be considered. Marley has a unit to fit any geographical condition.

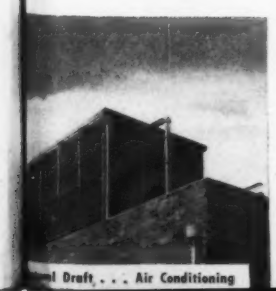
IS IT APPEARANCE? Marley has a wide range of designs that will blend with any building architecture. Or even become a part of the building itself. Marley engineers can help your architect give you a good looking as well as efficient installation.

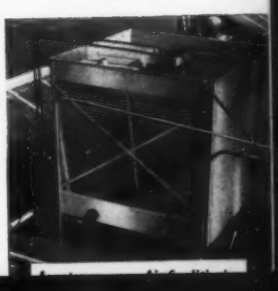

Double-Flow . . . Power


DriCooler . . . Gas Cooling

These are only a few of the problems you may face in the selection of a cooling tower or DriCooler. No matter what the problem, Marley Application Engineers have the answer to help you invest your dollars wisely and profitably.

MARLEY


Draft . . . Air Conditioning



OG-9

Write, Wire or Phone The Marley Company, Inc., Kansas City 15, Kansas.

Name _____ Title _____

Company _____

Address _____

City _____ Zone ____ State _____

☐ Please send "What's Your Cooling Tower IQ"

☐ Our Cooling Problem is _____

XUM

ACCURACY

not for its own sake but because it

Reduces your Piping Costs

Exceptional dimensional accuracy and uniformity of Midwest Welding Fittings speeds piping work and reduces cost. All pipe can be cut in advance according to drawings, with assurance of accurate fit. Welders do not have to spend costly time struggling to line up fittings and pipe. Welding proceeds rapidly, economically with no time-wasting compensation for inaccuracies.

All critical dimensions of Midwest Fittings are accurate and uniform. For example, Midwest Welding Elbows are first made slightly oversize. They are then reheated to forging temperature and brought to final size in compression dies. In addition to relieving stresses from forming and welding, this assures true circular cross-section, controlled wall thickness and accurate radius, included arc and tangents. Midwest Elbows and Tees have accurate welding bevels, included angles, etc., because all ends are machined simultaneously in special machines.

There is a Midwest Distributor near you. Get in touch with him for your fitting needs. Also ask for Catalog 48.

4098

MIDWEST

PIPING & SUPPLY COMPANY, Inc.

MAIN OFFICES: 1450 SO. SECOND STREET, ST. LOUIS 4, MO.

Sales Offices: New York 7 — 30 Church St. • Chicago 3 — 79 W. Monroe St.
Los Angeles 33 — 520 Anderson St. • Houston 2 — 1213 Capitol Ave.
Tulsa 3 — 533 Mayo Bldg. • South Boston 27 — 426 First St.
Stocking Distributors in All Principal Cities

MIDWEST WELDING FITTINGS Improve Piping Designs and Reduce Costs

Tame those touchy hydrocarbons

with a BJ Stuffingboxless Pump

Engineered for safe, simple, economical handling of butane, propane, ethane and other volatile hydrocarbons . . .

CAN'T ESCAPE

Leakage of pumped fluid to atmosphere is impossible. The motor and close-coupled pump are totally enclosed in a sealed pressure vessel. There's no fire hazard or danger to property or personnel caused by leakage.

ABLE TO CONTAIN HIGH PRESSURES

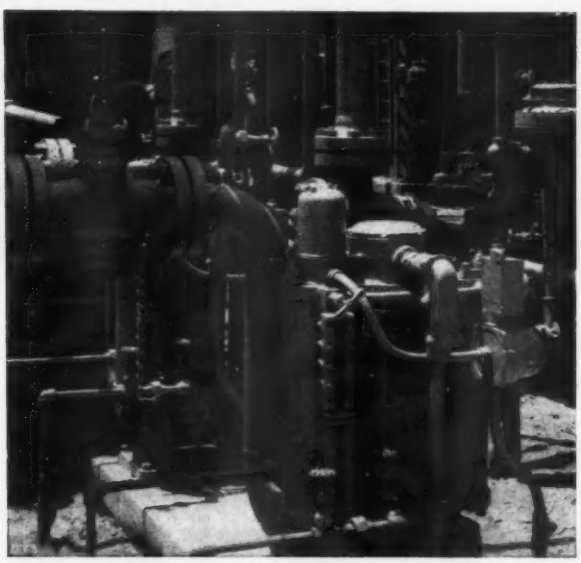
BJ's pressuring system maintains a predetermined pressure across the mechanical seal that separates the motor from the pump within the chamber. This pressure is constant, regardless of suction and discharge pressures.

NO "KEEPER" NEEDED

No special attendant is needed to guard against leakage and consequently no costly maintenance time is spent in repacking and adjusting.

OPERATING SAVINGS

While the first cost of the BJ Stuffingboxless Pump is somewhat higher, big and continuing savings are offered in operation. There's no product loss through leakage, no downtime due to flood-out.



THE *RIGHT* PUMP FOR YOUR JOB

The BJ Stuffingboxless Pump is available in a wide range of models and pressuring system combinations to meet individual requirements. Byron Jackson Co. engineers are ready to help you secure the BJ Stuffingboxless Pump best suited to your job. Write, wire or phone today.

Byron Jackson Co.

Since 1872

P. O. Box 2017 Terminal Annex, Los Angeles 54, Calif.

OFFICES IN PRINCIPAL CITIES

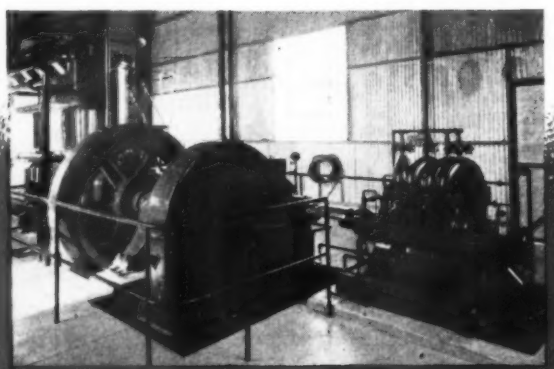
⇦ **THESE BJ STUFFINGBOXLESS PUMPS** handle ethane in a de-ethanizing operation. Pumping temperature is 80° F; suction pressure 490 psig; discharge pressure 520 psig; capacity 100 gpm; speed 3550 rpm; total head 165'; and specific gravity 0.42.

XUM

TODAY, FARREL SPEED INCREASERS ARE TRANSMITTING MORE THAN...

¼ MILLION HORSEPOWER

A



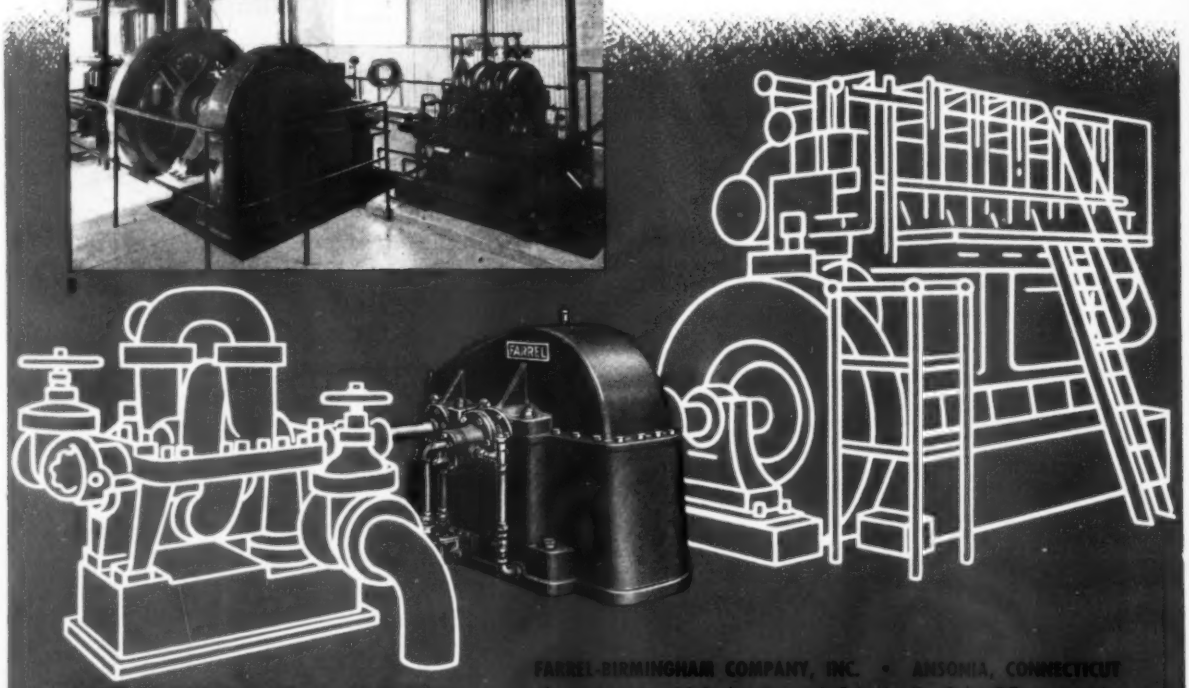
B

It was in 1932 that Farrel first developed a standard series of speed increasers for pipe line pumping service. Since then, hundreds and hundreds of units have been installed throughout the oil industry.

The record of these speed increasers — *every one is still in operation, serving as well as on the day it was installed*—provides a virtual guarantee of trouble-free performance.

The modern line of Farrel type SI units consists of 49 standard sizes with speed ratios ranging from 1:1 to 12:1. For higher ratios, units using two sets of gears are supplied with ratio range from 12:1 to 40:1.

For full information about these service-proved speed increasers, write for your copy of Bulletin No. 448A. No cost or obligation.



A Five speed increasers transmitting 200 HP with a 10½ to 1 step-up, driving high pressure pipe line centrifugal pumps. This company has over sixty similar units in operation.

B Farrel unit transmitting 250 HP with a 12 to 1 step-up from a gas engine to a centrifugal pump. This unit was installed in 1932, and is still in operation.

FARREL-BIRMINGHAM COMPANY, INC. • ANSONIA, CONNECTICUT

Plants: Ansonia and Derby, Conn., Buffalo, N. Y. *Sales Offices:* Ansonia, Buffalo, New York, Boston, Pittsburgh, Akron, Cleveland, Cincinnati, Detroit, Chicago, Los Angeles, New Orleans

OIL FIELD REPRESENTATIVES:

Hercules-Lupfer Engine Sales Co., 124 N. Boston St., Tulsa 1, Okla.
V. W. Osborne, 832-A M. & M. Building, Houston 2, Texas

Farrel-Birmingham®

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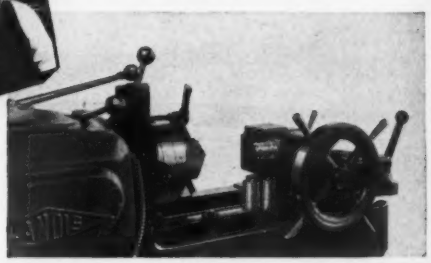
A COMPLETE Thread Engineering SERVICE

- Product Design
- Process Development
- All Types of Threading Equipment
- Special Applications



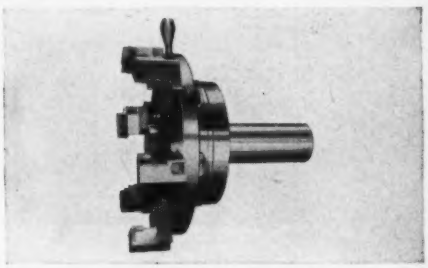
A 1½" Single LANDMACO Machine equipped with special work holding fixture for threading adapter sleeves.

New and improved products often create unprecedented threading problems—both in design and production. Realizing this, we offer all manufacturers the help of our Thread Engineering Service in efficiently and economically solving their Thread Problems.

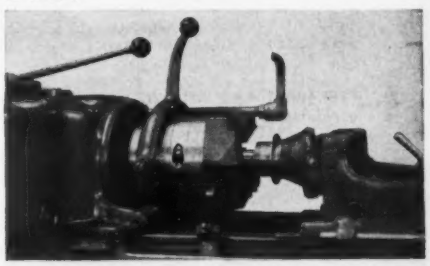
The difficulty may be in designing a thread which will function properly as an operating part, or in producing a thread already designed. Whatever the problem our Engineering Department is ready to help with advice and assistance—or to undertake the solution alone.

After examining all phases of the problem, the necessary recommendations will be made on basic Thread Design, the production process, and the Threading Equipment that should be used. For example, often a difficult Thread Production problem can be solved with a slight change in basic Thread Design. Occasionally, a job is so unique that special equipment is needed —three such Special Equipment Applications developed by our Engineering Department are illustrated below.

Whatever your Thread Problem, use our THREAD ENGINEERING SERVICE. Hundreds of manufacturers have been able to perform difficult threading operations efficiently and economically with Landis Threading Equipment. The years of Thread Experience and Engineering Know-How that has brought LANDIS to the fore in Thread Generating is at your service. May we help you?



A Special Die Head (LANDMATIC 40AXX) designed and built to thread valve seat rings up to diameters of 14¾".



A 1½" Single LANDMACO Machine equipped with special carriage front for threading axle housings.

LANDIS *Machine* COMPANY · WAYNESBORO PENNSYLVANIA

Represented in the Domestic Oil Fields by: Colcord-Wright Machinery & Supply Co., St. Louis, Mo.; C. J. Harter Machinery, Houston, Texas; Frederic-Baker Co., New Orleans, La.; Moore Machinery Co., Los Angeles and San Francisco, Calif.; Hendrie & Bolthoff Mfg. & Supply Co., Denver, Colo.

XUM

Why are "Caterpillar" Diesel Tractors, Engines and other equipment preferred in pipeline operation and on most every important pipeline construction project in the world? The answer could be expressed in a million words, but nine are enough:

THEY WOULDN'T BE THERE IF THEY DIDN'T MAKE GOOD

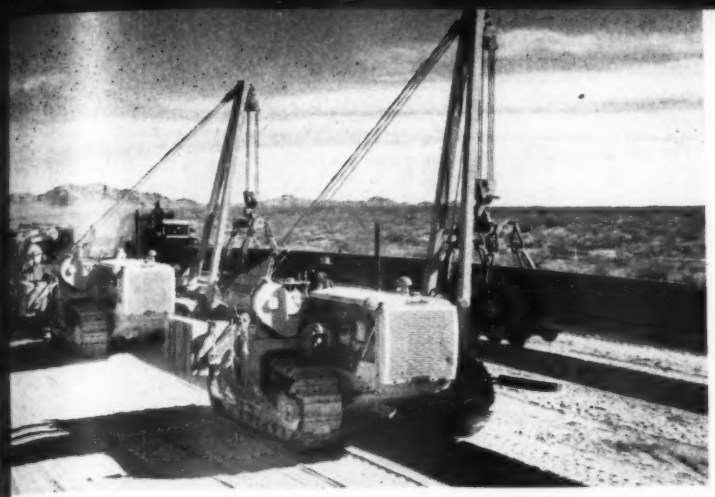
ROCK DRILLING with "Cat" powered Gardner-Denver compressor. Air drills are moved by "Cat" track-type Tractor equipped with side-boom. *Tennessee.*

CLEARING RIGHT-OF-WAY for pipeline with a "Cat" D8 Tractor and No. 8A Bulldozer. *Alabama.* (Same unit handy for back-filling.)

DIGGING TRENCH for pipeline with a Buckeye ditcher powered by a "Caterpillar" D13000 Engine. *Mississippi.*

PREPARING AND WELDING PIPE SECTIONS with power generated by a "Cat" D13000 Electric Set. *Georgia.*

XUM



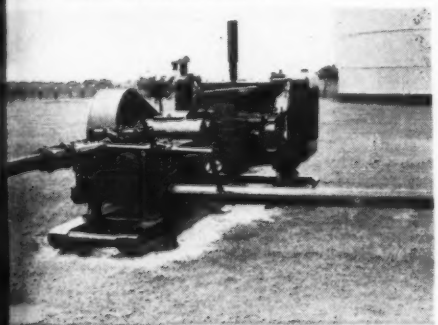
STRINGING PIPE in wrapping-doping operation with two "Cat" D8 Tractors equipped with offset track and side-booms. *California.*

WELDING TRESTLE with a "Cat" D311 powered General Electric welder. *Kansas.*

HILLSIDE TRENCHING with a "Cat" powered Lorain backhoe. A "Cat" D7 Tractor holds the excavator in position. *California.*

PIPELINE PUMPING. A battery of four "Caterpillar" D17000s on pipeline pumps. Skid bases make them easy to move from station to station to offer complete flexibility. *Texas.*

TANK FARM PUMPING with a "Cat" D8800 Engine driving the pump. *Texas.*



STANDARDIZE and ECONOMIZE

Make all your power equipment "Caterpillar" and give yourself the advantages of (1) economical, dependable and long-lasting units; (2) quick, simplified parts-and-repair service through one manufacturer and one dealer organization that is never far from anywhere.

COMPARE

Watch "Caterpillar" equipment at work on any operation; ask your dealer for a demonstration of any unit. It will make it easy to understand why the world bought more than $250,000,000 worth of "Caterpillar" products in 1949.

CATERPILLAR • **PEORIA, ILLINOIS**

REG. U.S. PAT. OFF.

CATERPILLAR

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DIESEL ENGINES

TRACTORS • MOTOR GRADERS

EARTHMOVING EQUIPMENT

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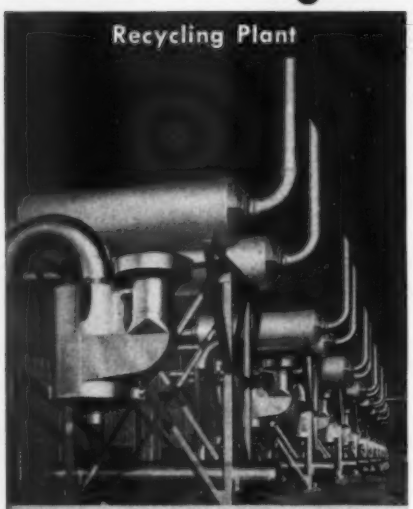
In the Petroleum Industry

Look to BURGESS-MANNING
Leader in Engine and Compressor Noise Reduction



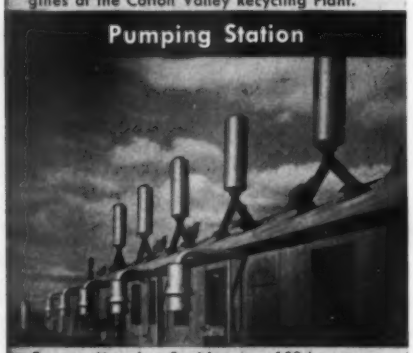
Burgess-Manning Snubbers used on Clark engines at the Cotton Valley Recycling Plant.

Burgess-Manning Snubbers used in a pipe line station.

Almost twenty-five years' experience in the design and application of Snubbers has given Burgess-Manning the know-how to help solve your engine and compressor noise reduction problems.

Burgess-Manning Snubbers smooth the flow of exhaust gas or intake air without restricting gas flow. Exhaust or intake pulses of gas are effectively snubbed so that the oscillating flow of gas is smoothed to a unidirectional flow.

If you are installing engines or compressors, let Burgess-Manning submit Snubber recommendations. Long experience guarantees complete satisfaction.



Burgess-Manning Snubbers on 180-hp gas engines used by a Kansas plant.

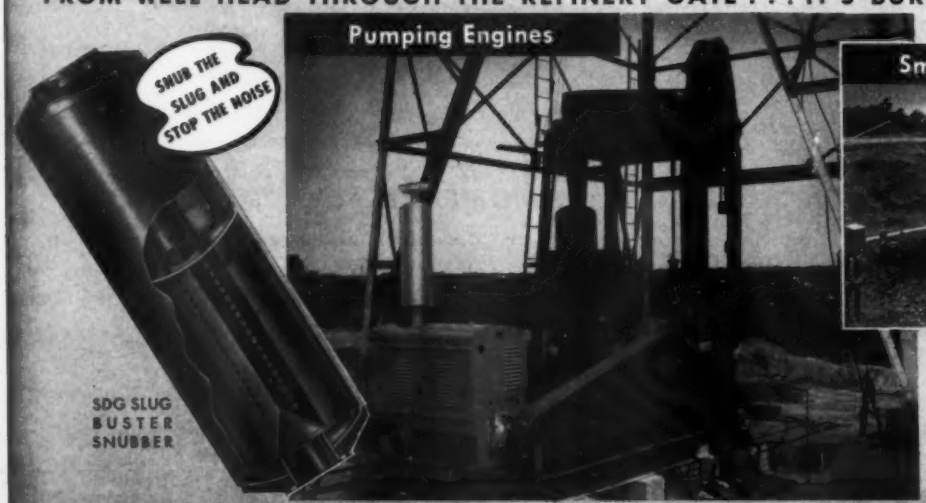
Burgess-Manning Snubbers used on engines of a pressure maintenance plant.

BURGESS-MANNING COMPANY

LIBERTYVILLE, ILLINOIS

749-G East Park Ave.

FROM WELL HEAD THROUGH THE REFINERY GATE . . . IT'S BURGESS-MANNING



Burgess-Manning Snubbers on pumping engine of the Peppers Refining Co.

Burgess-Manning Snubber installed on pipe line engine of the Magnolia Pipe Line Company.

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ELLERBEE BROTHERS

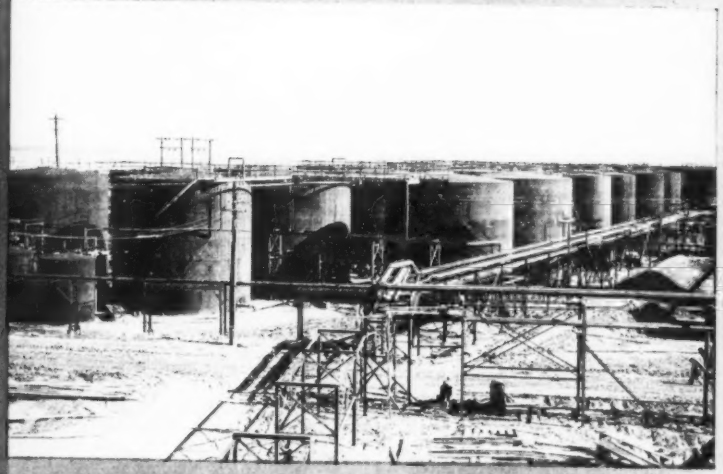
HAS NOW COMPLETED CONTRACTS FOR MOST OF THE MAJOR OIL AND CHEMICAL COMPANIES ON THE GULF COAST

One of our best recommendations is a list of the customers we keep! Ellerbee Brothers has now performed contracts for most of the major oil and chemical companies on the Gulf Coast. Repeat work has been done for many of these majors. We feel our success has resulted from the tested formula of experienced and capable personnel working with modern equipment under the personal supervision of men with as much as 20 years' experience who take personal pride in each job. We will appreciate an inquiry from you. Write today for the Ellerbee Brothers brochure.

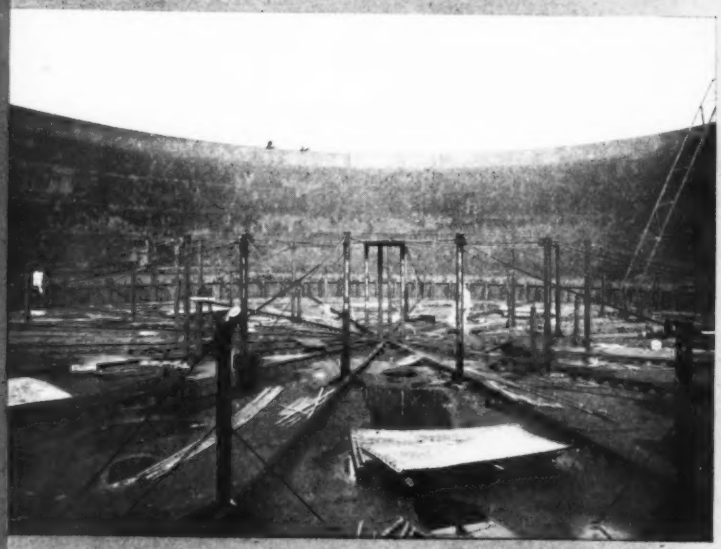
ELLERBEE BROTHERS

P. O. BOX 857 PORT ARTHUR, TEXAS

Laying 20" diameter tank farm piping at Mid-Valley Pipe Line Company's Mayersville, Miss., station.



Part of the 103 miscellaneous size welded tanks and overhead piping erected under one contract for a large Gulf Coast Oil company.



This 117' diameter pan type floating roof tank constructed for a major Gulf Coast refining company. Galvanized shoes are in foreground.

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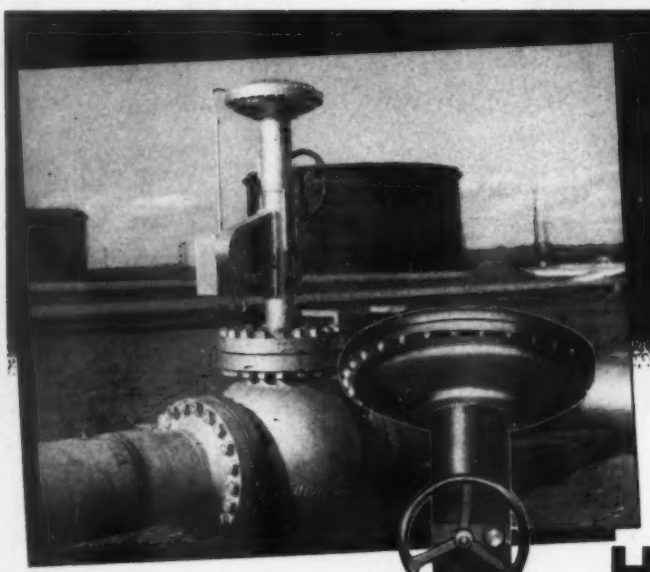
AUTOMATIC CONTROL EQUIPMENT

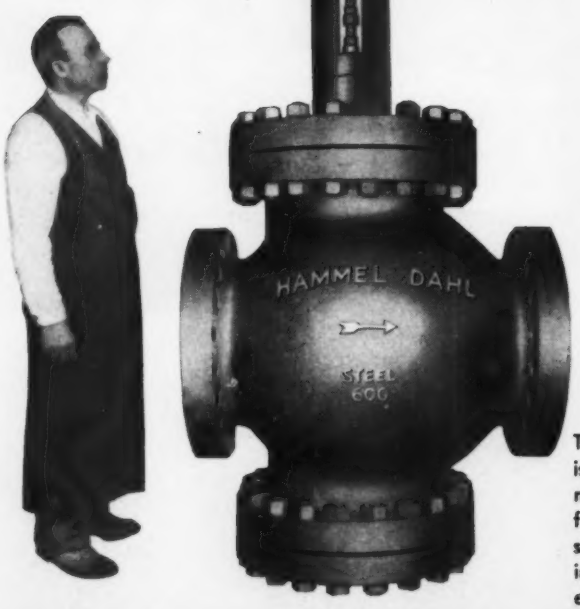
ENGINEERED DESIGN BY **HAMMEL-DAHL**



For PIPE LINE INSTALLATIONS

Specify HAMMEL-DAHL

"The World's Finest Control Valve"



The 16" Hammel-Dahl, 3000 Series, Diaphragm Control Valve illustrated is typical of the many Hammel-Dahl Valves used in major pipe line installations.

The oversized bowl of the valve body has been designed to assure minimum pressure loss. Thru bolting on the bonnet and blind flange, together with the self-supporting ALLSTEEL Superstructure, are the ultimate in rugged construction.

Valve seats are welded integrally with the valve body. The completely balanced valve plug is top and bottom guided in hexagonal, hardened stainless steel guide bushings. The hexagonal guiding absolutely prevents the valve plug from spinning.

The continuously connected handwheel illustrated is optional equipment. Its use, however, permits manual operation in case of instrument or air failure. Every feature in the valve has been designed specifically for the rugged service required in pipe line operation and to insure many years of economical and satisfactory service.

HAMMEL-DAHL COMPANY

243 RICHMOND STREET, PROVIDENCE 3, R. I., U.S.A.

ALBANY BOSTON BUFFALO CHICAGO CINCINNATI CLEVELAND DETROIT
HOUSTON KINGSPORT, TENN. LOS ANGELES NEW YORK PITTSBURGH SAN FRANCISCO
SEATTLE ST. LOUIS SYRACUSE TOLEDO TULSA WILMINGTON, DEL.

In Canada: Railway & Power Engineering Corporation, Ltd.

Round the clock Performance

Tour after tour, day after day, year after year . . . that's the kind of continuous 'round-the-clock performance rendered by all Emsco products. Take the Emsco GA-350 Drilling Rig for example. Here's a 350-horsepower rig engineered for day-in, day-out trouble-free performance. An automatic oil bath system eliminates costly, time-consuming shut-downs for oiling and greasing. Air-operated controls speed-up drilling operations, lower drilling costs. Picture a GA-350 with an Emsco Portable Mast, NS-15 Rotary, AE-4 Swivel and ND-36 Traveling Block on any oil field panorama, and you have the key to faster, easier and more economical drilling of medium depth holes.

THE CONTINENTAL SUPPLY COMPANY

General Offices: DALLAS, TEXAS • The Continental Supply Co., Limited, 216 Lancaster Bldg., Calgary, Alberta • *Export Division:* The Continental Supply Company, Inc., 30 Rockefeller Plaza, New York, N.Y. • *Representatives:* Argentina Bolivia • Brazil • Chile • China • Colombia • England Ecuador • Peru • Trinidad • Uruguay • Venezuela

CONTINENTAL

ADV 545-50

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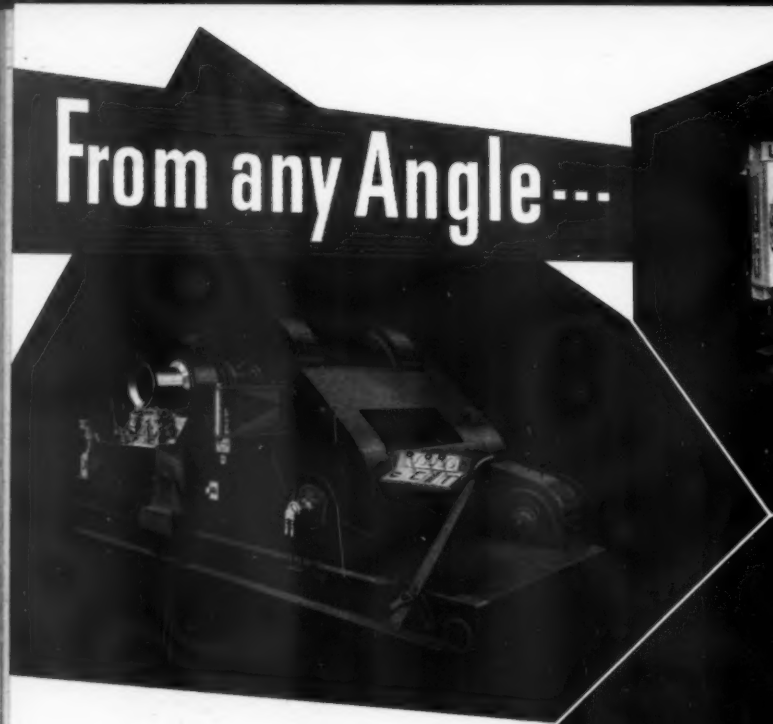
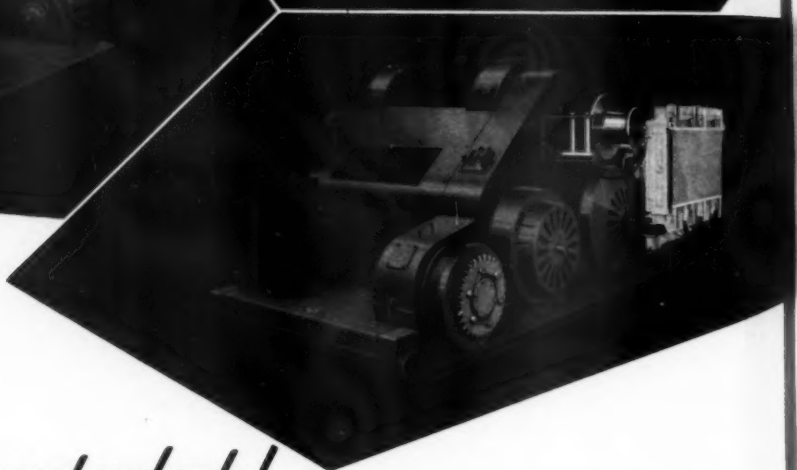
From any Angle---





THE NEW EMSCO GA-250-T

is outstanding by any standards!

A 250 HP SINGLE ENGINE TORQUE CONVERTER DRAWWORKS FOR DRILLING TO 5000 FEET

Here's a truly outstanding power drawworks designed to meet your requirements for drilling to 5000 feet or for deep workover operations. You'll find that the new Emsco GA-250-T offers many important operating advantages heretofore unobtainable with power rigs of this class. It is a completely portable, lightweight, rugged, highly versatile, low-cost rig of sound functional design. The use of a chain drive between the engine and torque converter permits use of *any* make of engine of proper horsepower *regardless of engine speed.* The hydraulic torque converter provides an infinite range of speeds and insures use of maximum horsepower at all times. Air-operated clutches speed drilling operations. Simplified one-lever console mounted controls increases drilling efficiency and promotes safety.

Compare the new Emsco GA-250-T with any other rig in its class . . . you'll find that feature for feature, dollar for dollar, you can't beat the GA-250-T for fast, economical drilling to 5000 feet. Your nearest Continental-Emsco representative will gladly furnish you with complete information on the GA-250-T . . . the newest addition to the world-famous, field-proven Emsco line of drilling rigs.

ONLY THE EMSCO GA-250-T DRILLING RIG OFFERS ALL THESE OUTSTANDING OPERATING ADVANTAGES

COMPARE THESE FEATURES WITH ANY OTHER RIG IN ITS CLASS

★ **WIDE CHOICE OF ENGINES**—Torque converter mounted separate from engine permits use of any standard types and makes of engines of proper horsepower, *regardless of speed of engine.*

★ **HYDRAULIC TWIN DISC TORQUE CONVERTER**—Automatically provides an infinite range of speeds at maximum horsepower . . . eliminates shock loads on bearings, shafts and chains . . . increases drilling efficiency.

★ **SINGLE OR DOUBLE DRUM UNITS**—Free-spooling sand reel drum available as optional equipment. Airflex clutch controls sand reel drive. Drum capacity, 9/16" line—11,250'.

★ **ENCLOSED WATER-COOLED BRAKE RIMS**—6 13/16" wide x 36 1/4" diameter drum shaft brake rims are fully enclosed and water-cooled. Drum: 16" dia. x 39" long. Wire line capacity—1" line—3000'.

★ **FINGER TIP CONSOLE CONTROL**—All controls are centralized at driller's console. Simplified design permits operation of hi, low or reverse drive and engine throttle with one *hand control.*

NEW BULLETIN—New Emsco Bulletin F-175 gives complete information on the new Emsco GA-250-T Drilling Rig. Copies available upon request.

CONTINENTAL

ADV 548-50

EMSCO DERRICK & EQUIPMENT COMPANY

Houston, Texas • LOS ANGELES, CALIFORNIA • Garland, Texas

Distributors: Mid-Continent: THE CONTINENTAL SUPPLY COMPANY, Dallas, Texas
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EMSCO

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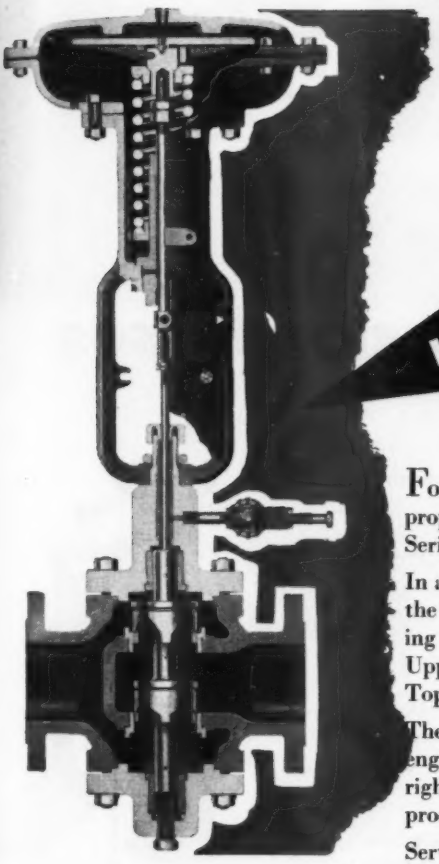
• There are many diaphragm control valves...but

You want the

HONEYWELL SERIES "700"



FOR a diaphragm-operated valve that affords utmost precision in proportional high-lift control . . . your best bet is the Honeywell Series "700."

In addition to the usual features you expect to find in a fine valve, the "700" gives you: Pre-molded Neoprene Diaphragm with Rolling Action, Pivot-Mounted Inner Plate and Cradle-Mounted Upper Spring Flange, Duplex Bearing for Stem, One-Piece Bonnet, Top and Bottom-Guided Disc.

The quality of the Series "700" stems from years of research and engineering know-how . . . in designing the right valve, from the right material, with the right specifications for the more complex process applications.

Service, when needed, is available from the Honeywell nationwide network of branch offices and factory-trained field engineers . . . as near to you as your phone. Call in your local Honeywell engineer today . . . for detailed information.

Investigate the Series "700" . . . today . . . write for Bulletin 700-2

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 1906 Windrim Ave., Philadelphia 44, Pa. Offices in more than 80 principal cities of the United States, Canada and throughout the world.

MINNEAPOLIS

Honeywell

VALVE PRODUCTS

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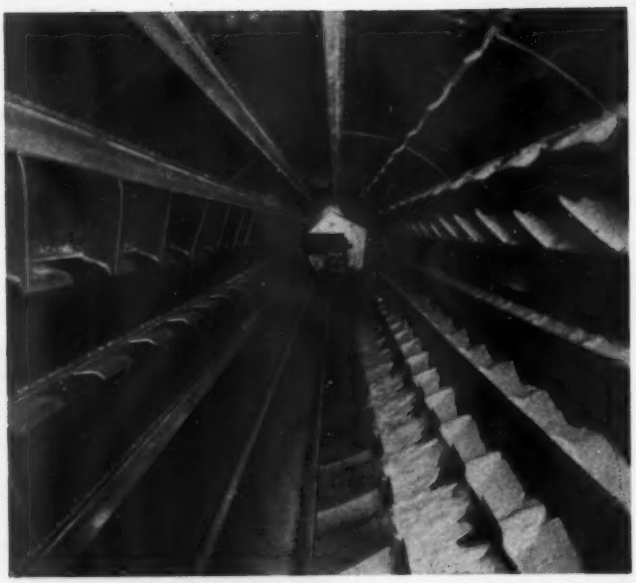


Linings and flights of this rotary salt dryer at the Worcester Salt Company are made of Monel.

Filter used in the production of fertilizer from potassium chloride-sodium chloride mixtures. All contact parts are Monel.

Handling salts...brine?

Here's how to cut corrosion losses

If sodium chloride or alkali salts are eating holes in your maintenance budget, here's something you should know . . .

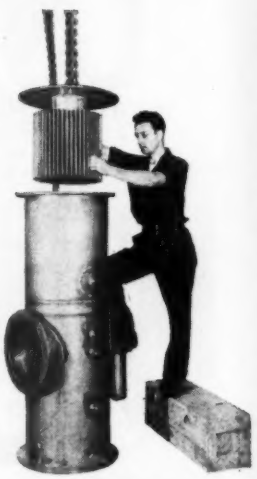
Monel® . . . practical, economical, workable . . . has for many years stood the severe test of actual industrial usage in handling corrosive salts.

In the presence of salts such as sodium chloride, *Monel* shows an economical corrosion rate.

Common alkali salts (hypochlorites excepted) and acid salts, such as zinc chloride, ammonium sulfate, aluminum sulfate, and ammonium chloride, may be handled under many conditions in *Monel* equipment.

Typical applications of *Monel* and *Monel*-Clad Steel in these fields are: dryers, vacuum evaporator tubes, saturators, pumps, ejectors, centrifugal driers, crystallizers, storage tanks, piping, screens, filters, feed-water pumps, valves and valve parts.

Monel is produced in many standard mill forms—sheet, strip, tube, angles, rod, wire castings and forgings. For specific information for your application, write directly to Inco.



Water still used aboard U. S. Coast Guard light ships, for distilling fresh water from sea water. All parts and piping vulnerable to corrosion are made of Monel.

THE INTERNATIONAL NICKEL COMPANY, INC.

67 Wall Street, New York 5, N. Y.

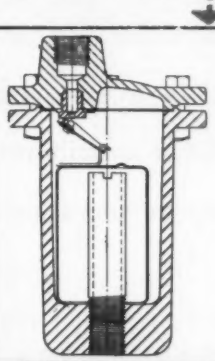
EMBLEM OF SERVICE INCO TRADE MARK

MONEL . . . *for Minimum Maintenance*

"Here's a Forged Steel Trap . . . for only $14.00 list"

SMALL PRICE
BIG BENEFITS

SAFETY . . . DEPENDABILITY



Cross section of an Armstrong No. 3211 forged steel trap. Forged cap and body, compressed graphited asbestos gasket, all stainless mechanism. This trap will take high temperature and shock without danger of fracture.

SMALL SIZE.. LIGHT WEIGHT

NOW, for many applications, refineries and natural gasoline plants can have the additional safety of a forged steel steam trap for only a few dollars more than a cast iron trap of comparable size. The Armstrong No. 3211 trap illustrated will withstand fire or explosion without danger of fracture. It is the baby of the Armstrong forged steel line, a low priced trap for working pressures up to 250 psi; design pressure, 450 psi. Capacity range 750 to 1000 lbs/hr continuous. ½" or ¾" pipe connections. Diameter 4¼"; height 7"; weight 8 lbs. This trap is a natural for refinery and natural gasoline plant service.

For higher pressures and larger capacities Armstrong builds a complete line of heavy duty forged steel traps. Ask your nearby Armstrong representative to quote on the traps you need now.

ARMSTRONG MACHINE WORKS
868 Maple St., Three Rivers, Mich.

SEND FOR your copy of the Armstrong Steam Trap Book giving complete data and prices on all Armstrong steam traps, both forged and cast bodies for all pressures, all applications. This 36-page book is a valuable reference for any engineer working with selection and installation of steam traps.

ARMSTRONG STEAM TRAPS

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Break your emulsions with BREAXIT

•

On • The • Spot Testing *and* To • Your • Lease Delivery

The BREAXITS are emulsion-breaking compounds specially adapted to each job on the job. A trained, field-service engineer tests live oil *on your lease* and determines the type and amount of BREAXIT to give you pipe line oil. The nearest BREAXIT distributor makes delivery to your *lease.*

BREAXIT
REGISTERED U. S. PAT. OFF.

is sold by . . .

HUMBLE OIL & REFINING CO.

HOUSTON 1, TEXAS

You asked for it... HERE IT IS—

AO's New Metal Ful-Vue Safety GOGGLE!

HANDSOMER IN APPEARANCE • STRONGER IN STRUCTURE

With the introduction of the F4100 Metal Ful-Vue, AO's protection against the impact of flying particles reaches its highest development. Here in one goggle, with or without side shields, workers can obtain the peace of mind which comes from assured safety . . . the utmost in comfort over nose and temples . . . the very finest in EYE APPEAL PLUS EYE PROTECTION!

QUICK FACTS

NEW EYEWIRE — A major contribution to *looks with strength.* Outer edges are square instead of round with a deep groove to hold lenses securely in place. Beaded engraving adds a distinctive touch. The lightweight eyewire is strong and durable.

NEW RUGGED ENDPIECE—Streamlined . . . with a wide bearing surface at hinge which minimizes temple drop. Screw heads are countersunk and flush with endpieces for added good looks, non-sagging security.

NEW LIGHTWEIGHT TEMPLE—Oval temples instead of round for greater comfort and attractiveness. Easily adjusted, perspiration proof. Insulated semi or half tubing is another appearance improver and will outlast life of the temple. Tubing will not come off and it can't be discolored by dirt or grease. Both the temple and endpiece screws are AO patented "Ever-tite" construction . . . they keep tight in service yet remove quickly when replacing lenses.

IMPROVED GUARD ARMS AND BRIDGE — Guard Arms are newly shaped — longer with more opening for added ease of adjustment. The bridge is double braced with four contact joints — a feature found only in AO Ful-Vue spectacle goggles.

NEW SIDE SHIELD CONSTRUCTION — A real time saver . . . new one-piece binder and eyewire construction *eliminates necessity of inserting the screen before inserting lenses!* Replacement of lenses can now be made without any interference with or from the side shield.

For these and many other reasons, be sure to see the new F4100. YOUR NEAREST AO SAFETY REPRESENTATIVE CAN SUPPLY YOU.

American Optical
SAFETY PRODUCTS DIVISION

SOUTHBRIDGE, MASSACHUSETTS • BRANCHES IN PRINCIPAL CITIES

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There's no better proof of effective, economical dehydrating performance than industry-wide acceptance and usage. The petroleum industry knows, and uses

Tret-O-lite

You can't get better dehydrating reagents — no one can give you better service. If you have other production problems, ask about **THESE** Tretolite products:

CORROSION INHIBITORS

SCALE PREVENTIVES

PARAFFIN REMOVERS

WATER DE-OILERS

TRETOLITE COMPANY

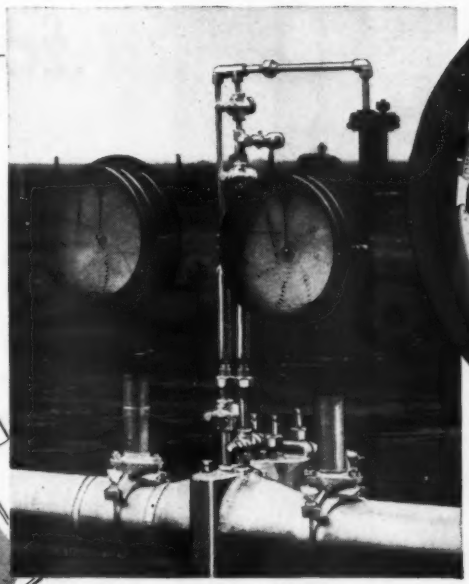
Manufacturing Chemists

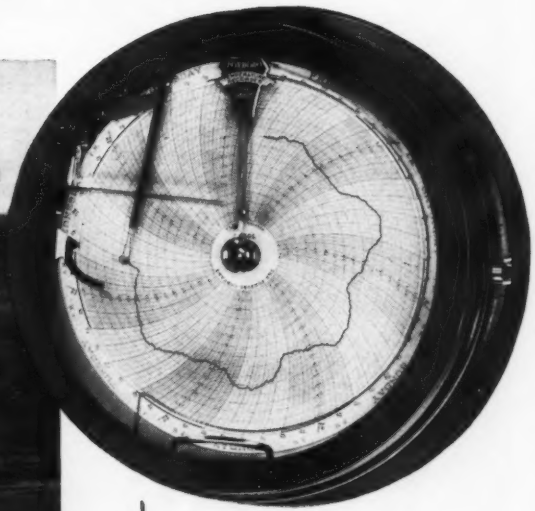
T50-3

ST. LOUIS 19, MISSOURI • LOS ANGELES 22, CALIF.

HOW TO KEEP THE WEATHER FROM

Picking your Pocketbook





Left—The Anti-Ambi Recorder.
Right — Foxboro Flow Meter.

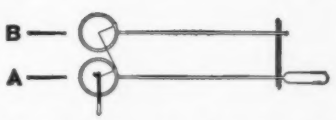
If you're selling gas, let Foxboro Anti-Ambi Temperature Recorders protect you against expansion or contraction losses due to the ups and downs of the weather. They'll give you continuous, accurate records of gas temperature . . . permitting full correction for every variation and precise accounting of deliveries.

Temperature changes raise havoc with gas metering. With orifice meters, a variation of only 10°F., unless corrected for, causes an error of 1% in metered volume. (With displacement meters, this error is twice as great.) When you're selling gas, this means an actual out-of-pocket cash loss if the temperature drops, or the delivery of sub-standard volume if the temperature rises.

Like other Foxboro Instruments for the oil and gas industry, the Anti-Ambi Recorder is extremely rugged as well as accurate. Designed for service in the "wide-open spaces", it has a weather-tight case. It's fully compensated for external temperature changes . . . built to operate under the roughest conditions, with a minimum amount of attention. These are reasons why more Foxboro Anti-Ambi Recorders are in service today than all other makes combined.

Get all the facts about these better-engineered instruments. Write for Bulletin 376. **The Foxboro Company, 60 Neponset Ave., Foxboro, Mass., U. S. A.**

TYPICAL FOXBORO REFINEMENTS



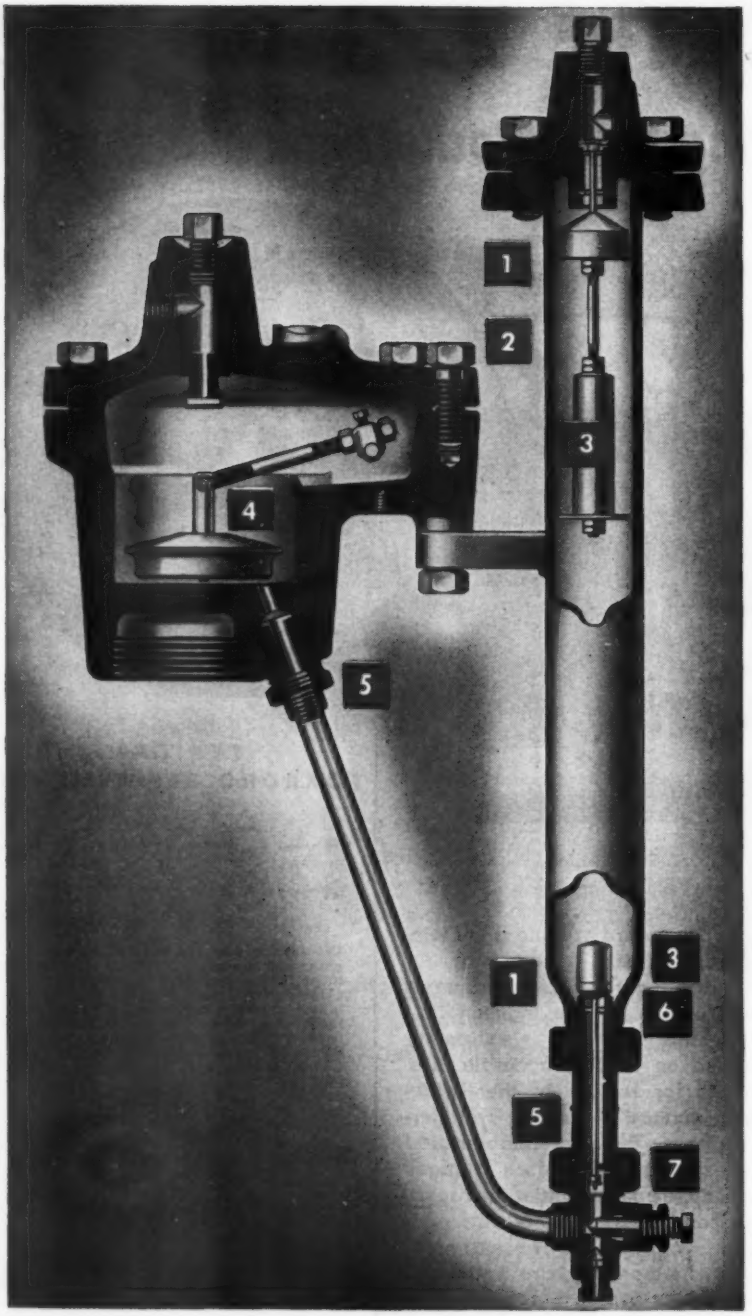
The diagram above shows the Foxboro automatic compensation for ambient temperatures. Both the primary measuring system (A) and compensating system (B) are contained in the same instrument case (and length of protective tubing). The compensating system acts as an automatic zero setting for the primary system. Instrument and compensation are calibrated at the same time.

This drawing shows the small diameter, quick-response bulb used with the Foxboro Anti-Ambi Thermometer. The bulb is made with a stainless steel neck to reduce conduction effects.

The bulb is protected by the special socket shown above. It has aluminum fins for rapid heat transfer to the bulb and a stainless steel extension to minimize heat conduction to the socket head.

FOXBORO REG. U. S. PAT. OFF.

Anti-Ambi THERMOMETERS



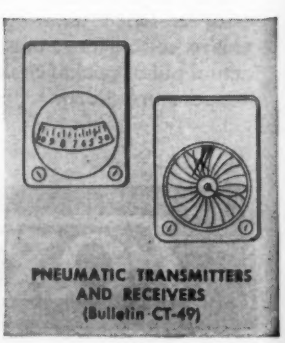
A NEW
for 1500

1. New Mercury Check Valves Stainless Steel Seats
2. Extended Hi-Side. Prevents Loss of Mercury on Reverse Flows
3. Plastic Check Valve Floats
4. Float in Low Side for Convenient Adjustment
5. Union Type Connections for Interchangeability of Range Tubes
6. Swaged Hi-Side Tube
7. New Pulsation Dampener

HIGH PRESSURE IRONCASE METERS
(Bulletin EG-40)

RELIANCE CBVA MOTOR VALVES
(Bulletin 50-A)

DRY TEST METERS
(Bulletin AG-3)



PNEUMATIC TRANSMITTERS AND RECEIVERS
(Bulletin CT-49)

ORIFICE METER
p.s.i. Working Pressure

Among the important operating and service improvements embodied in the American METRIC A-88 Series Orifice Meters are the following:

The mercury float is in the low side chamber, which permits cleaning and calibration with low side cover removed

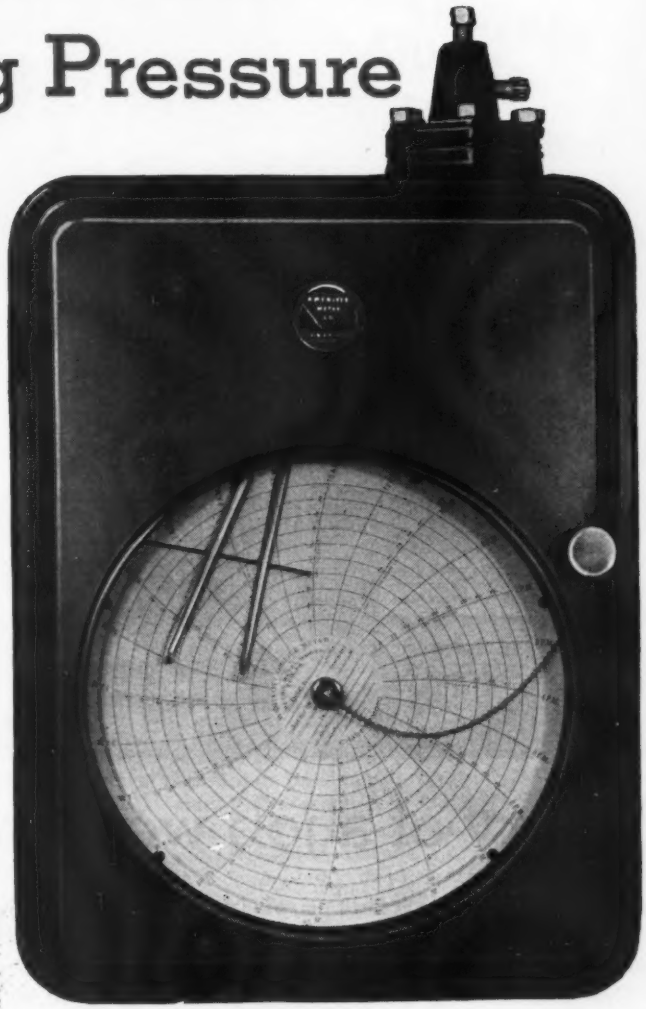
Union type seal tube connections permit interchanging 20", 50", 100" and 200" ranges. Other ranges up to 800" available

Over-range protection is provided by submerged check valve with long guided stem and stainless steel seat

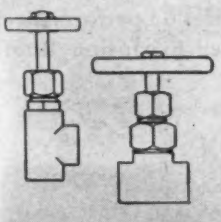
Under-range protection is provided by check valve with stainless steel seat and plastic float in extended high-side chamber

A new Teflon sealed stuffing box with monel shaft requires no grease or other lubrication furnished upon request

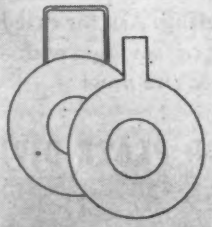
A-88 Series Orifice Meters will handle tough measurement problems. They are rugged, yet simple. They are particularly suitable for applications which must function properly where service inspections may be few and far between. They maintain the American Meter Company tradition of "*sustained accuracy at lower cost.*" Write for Bulletin.



American Meter Company
RECORDING ORIFICE METER
Diff. Range Inches of Water 10—20—50—100—200
Pressure Springs available for all applications



NEEDLE VALVES, SCREWED AND UNION BONNET
(Specification Sheet)



ORIFICE PLATES AND ORIFICE FLANGES
(Bulletin EG-2)

AMERICAN METER COMPANY
INCORPORATED (ESTABLISHED 1836)

60 East 42nd Street • New York 17, N. Y. • Albany • Alhambra
Atlanta • Baltimore • Birmingham • Boston • Chicago
Dallas • Denver • Erie • Fort Lauderdale • Houston
Joliet • Kansas City • Los Angeles • Minneapolis • Odessa
Philadelphia • Pittsburgh • San Francisco • Tulsa
In Canada—Canadian Meter Co., Ltd., Hamilton, Ontario

XUM

GRAVER
CONSERVATION AT WORK
for GREAT LAKES PIPE LINE COMPANY
Sioux Falls, S. D., Terminal. Three Graver Expansion Roof Tanks manifolded to 27 Graver cone roof tanks.

A story of a job well done...

●Several years ago, Graver built petroleum products tankage systems manifolded with Expansion Roof Tanks for the Great Lakes terminals at Sioux City and Des Moines, Iowa; Watertown and Sioux Falls, S. Dak., and Alexandria, Minn.

So satisfactory was the service of the Graver Expansion Roof Tanks that Great Lakes Pipe Line Co. included Expansion Roof Tanks in the specifications for its $55,000,000 expansion program.

The new Graver installations include five 80,000-barrel Expansion Roof Tanks at Minneapolis, four 55,000-barrel Expansion Roof Tanks at Omaha.

Graver installations at Des Moines (one 40,000-barrel Expansion Roof Tank and four 40,000-barrel cone roof tanks) and at Mankato, Minn. (one 40,000-barrel Expansion Roof Tank and three 40,000-barrel cone roof tanks) will be additions to present manifolded systems. Each of these Expansion Roof Tanks will have a 10-foot lift.

This repeat business speaks for itself—a tribute to Great Lakes' progress and testimony to Graver engineering. Ask for case histories on performance and vapor savings with Graver Expansion Roof Tanks. Write now!

GRAVER

FABRICATED PLATE DIVISION

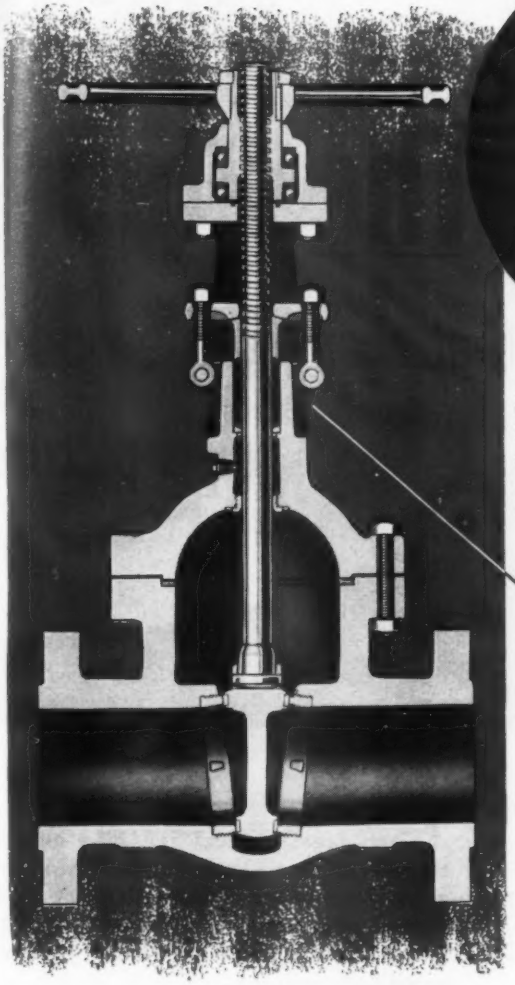
GRAVER TANK & MFG. CO., INC.

EAST CHICAGO, INDIANA

NEW YORK • PHILADELPHIA • CHICAGO • CATASAUQUA, PA. • HOUSTON • SAND SPRINGS, OKLA.

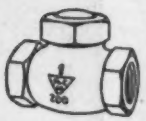
You'll benefit by using

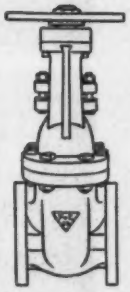
R·P&C
CAST STEEL VALVES

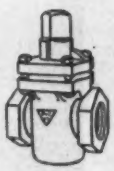


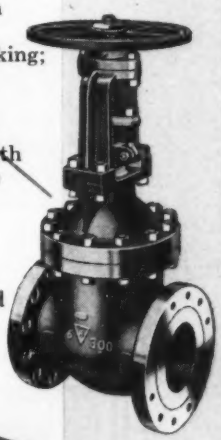
Note the **quality features** of this Gate Valve. They are typical of all valves in the R-P&C Cast Steel Line—gate, globe, angle and check valves in pressure classes 150 lb. through 1500 lb.

- **Ball Bearing Operating Nut** permits smooth operation with minimum effort.
- **One Piece Yoke with Cap** provides rigidity, perfect alignment and easy access to operating nut.
- **High Quality Packing** assures a tight stuffing box under all conditions—low stem friction—minimum servicing.
- **Gland and Follower with Ball Joint** applies uniform pressure on packing, prevents follower binding with stem.
- **Heat-treated Stainless Steel Stem** has high strength and corrosion resistance. Polished surface increases life of packing; T-head makes strong, self-aligning connection with wedge.
- **Solid I-Beam Wedge** is guided to proper seating by guide ribs cast integral with the body. Wedge seating surfaces are precision ground to fit perfectly with body seat rings.
- **Barrel-type Seat Rings** have heavy, uniform section; offer no points of high stress concentration; have broad seating surface, ground smooth for less wear—longer life. Port opening is full pipe diameter.









***In addition** to the standard line, R-P&C offers cast steel gate and globe valves with Pressure Sealed Bonnet joint—especially adapted for high pressure, high temperature service. For information, get in touch with your nearest R-P&C District Office.*

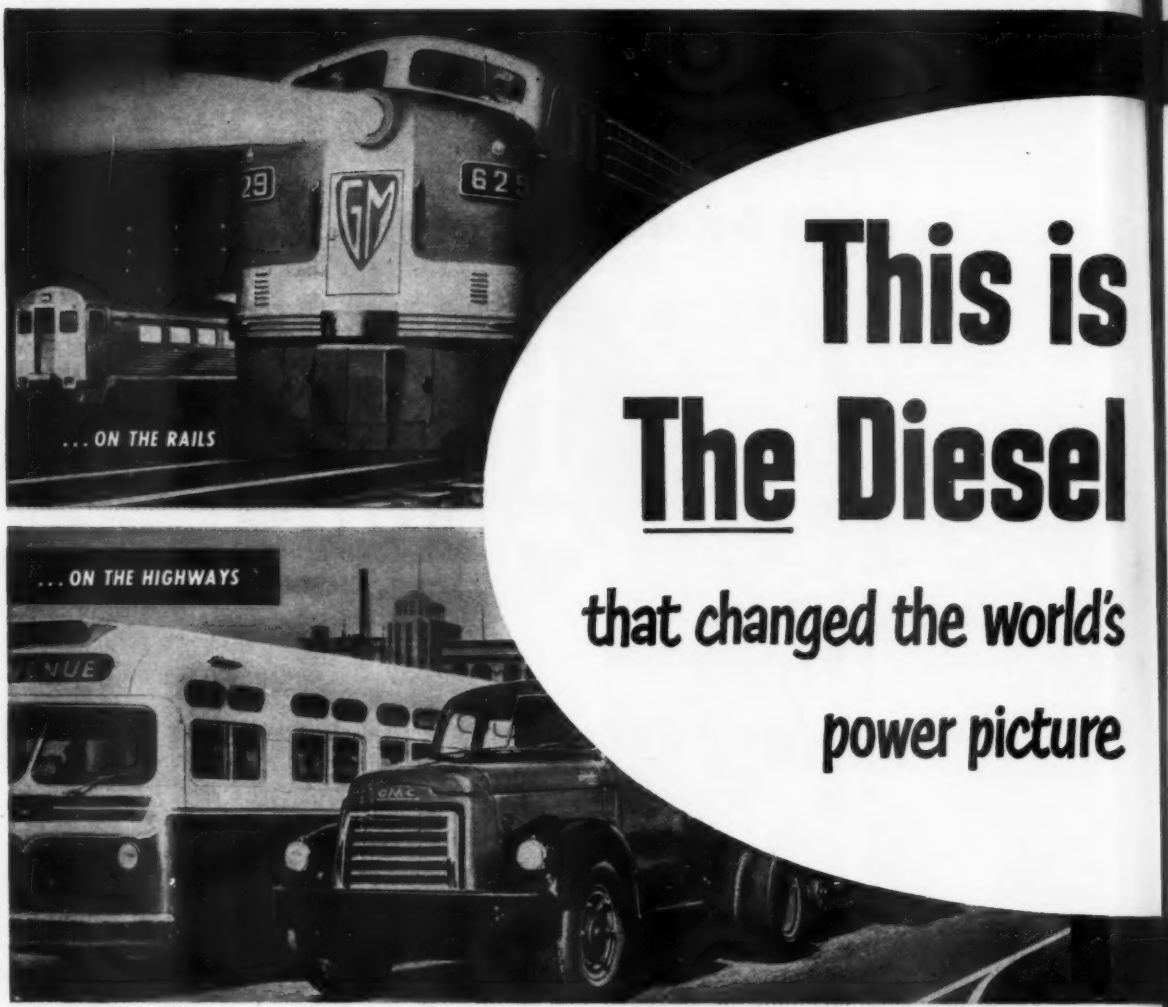
ACCO Reading, Pa., Atlanta, Baltimore, Boston, Chicago, Denver, Detroit, Houston, New York, Philadelphia, Pittsburgh, San Francisco, Bridgeport, Connecticut

R-P & C VALVE DIVISION
AMERICAN CHAIN & CABLE

TRADE MARK

READING-PRATT & CADY VALVES

XUM



This is The Diesel

that changed the world's power picture

ONE DIESEL—and one alone—blazed a trail which has won world-wide recognition for the oil-burning engine as the most economical source of smooth, dependable, agile power for locomotives, trucks, buses, marine and other mobile uses.

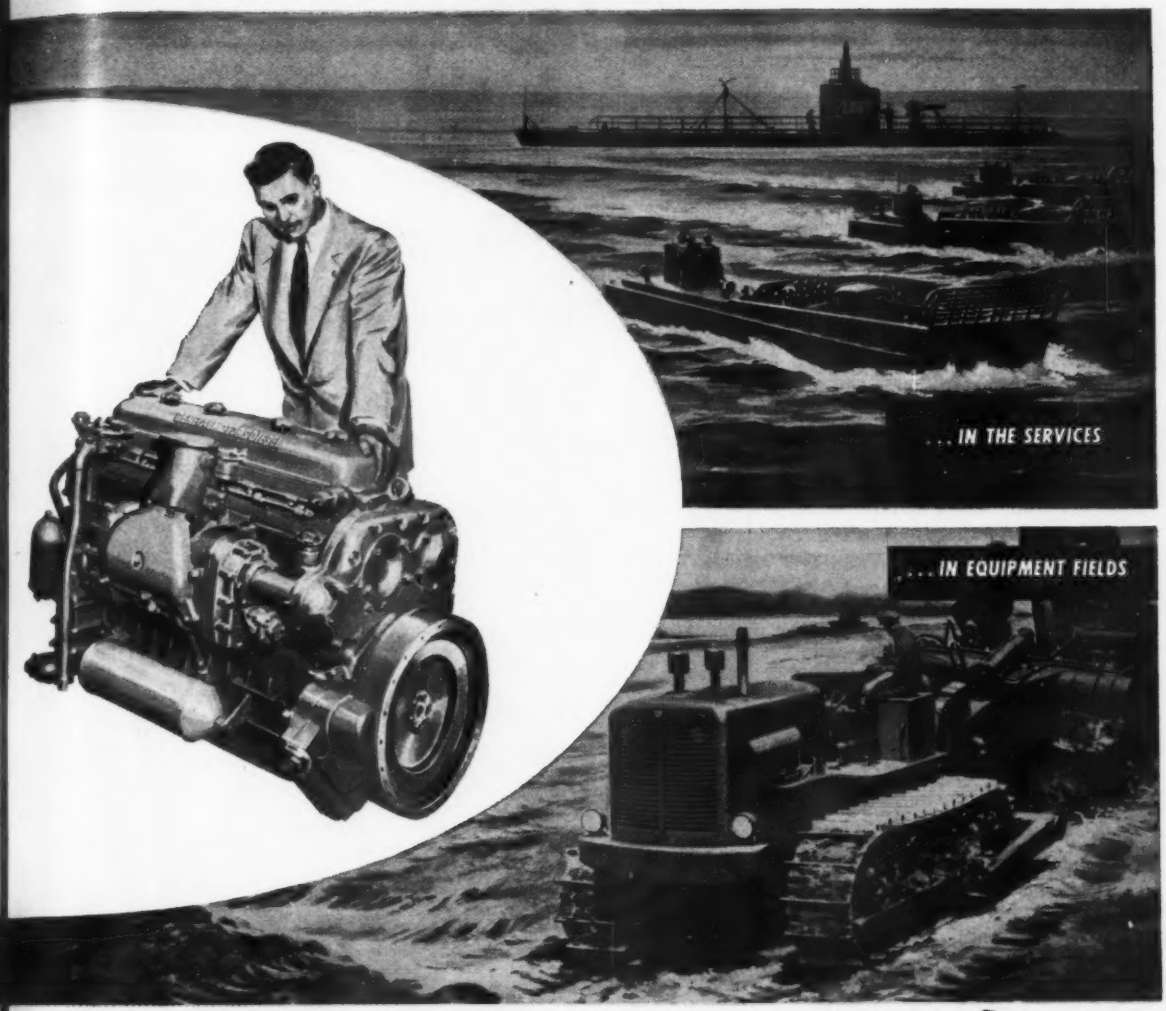
It is the General Motors Diesel engine, one size of which now drives most of America's crack passenger and freight trains. Another powers many of the Navy's submarines and other vessels.

And a third—the GM Series 71 engine—is the most widely used of all, totaling 46,000,000 horsepower. *It has surmounted the exacting conditions of War and met the economic requirements of Peace.* It has brought the same efficiency to a wide range of jobs, including many where Diesel power was never usable before.

That is because the "71," like all GM Diesels, is a two-cycle engine. Two-cycle means it produces power with every piston downstroke—in contrast to most other Diesels that generate power only on every second downstroke.

Equally important, GM Diesels have a direct jet-injection system that feeds fuel to cylinders in exactly metered charges—insuring better combustion and eliminating troublesome high-pressure fuel lines.

These basic differences make GM Diesels far more compact and much lighter than other Diesels of equal horsepower—without sacrificing ruggedness. These engines accelerate faster, are unmatched for smoothness, start quickly and are clean-burning.



"Your Key to Power Economy"

Today, GM Series 71 Diesel engines are taking the place of gasoline engines on many types of power jobs — of steam engines on land and sea — even of other Diesels because twelve years' experience has proved they are so dependable, so efficient, so economical.

General Motors 2-cycle Series 71 engines provide Diesel power at its best — *Diesel brawn without the bulk.*

Hear Henry J. Taylor on the air every MONDAY evening over the ABC Network, coast to coast.

Only GM Diesels provide all these advantages

- Smaller size, less weight per horsepower
- Two-cycle smoothness, power on every downstroke
- Quick starting, on its own fuel
- Unit injectors—no high-pressure fuel lines
- Rapid acceleration • Cleaner-burning
- Better high-altitude performance
- Easy accessibility

GM
GENERAL MOTORS
DIESEL POWER

DETROIT DIESEL ENGINE DIVISION

SINGLE ENGINES . . . Up to 275 H.P. DETROIT 28, MICHIGAN MULTIPLE UNITS . . . Up to 800 H.P.

GENERAL MOTORS

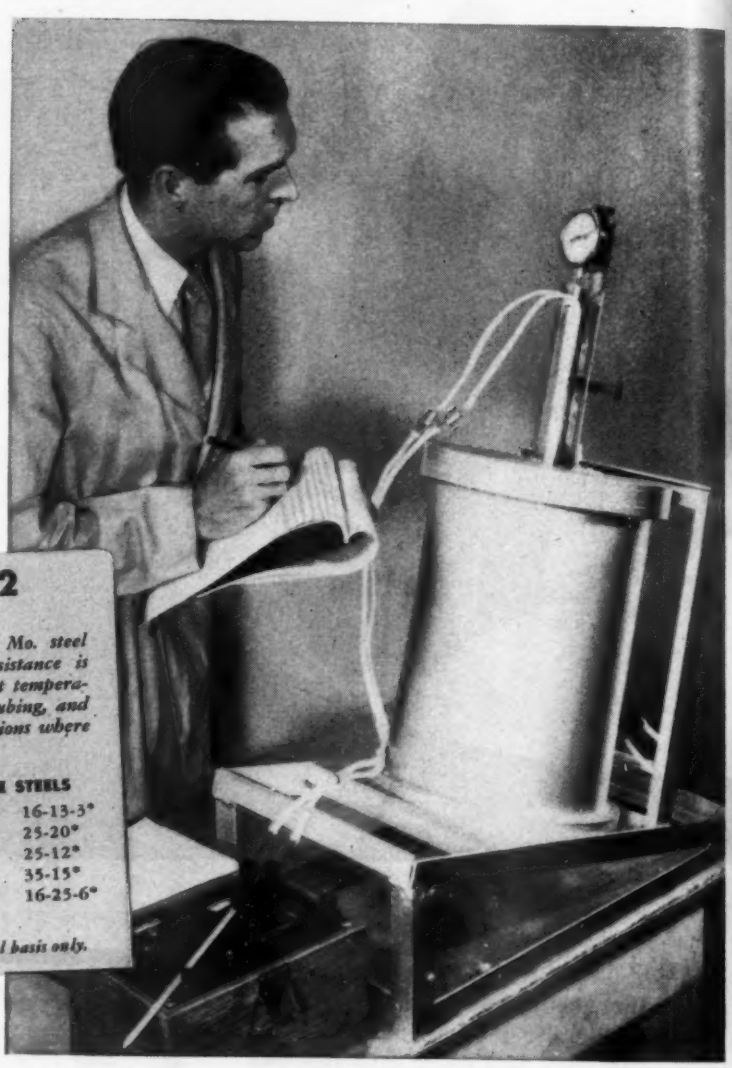
XUM

What to do about high temperature tube problems? Ask the experts!

MORE than one steel may solve your heat, pressure, corrosion and oxidation problems. But only *one* steel can give you the best life/cost ratio.

To get the one steel that gives you maximum tube life per dollar, call on the high temperature steel experts of The Timken Roller Bearing Company. Backed by more than 20 years of research, they have the widest field experience in high temperature applications. With 23 analyses to choose from, they can recommend the *right* tube for your job. And you can be certain of uniform quality because Timken® closely controls quality from melt shop through final inspection.

Let Timken's "RSQ"—Research, Supply, Quality—solve *your* tube problems. *Ask the experts!* Write The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".



This month Timken reports on:

DM-2

Recommended as replacement for 0.50% Mo. steel where greater corrosion and oxidation resistance is needed. For use in cracking furnace tubes at temperatures up to 1100° F., high pressure boiler tubing, and high temperature steam piping under conditions where graphitization may occur in 0.50% Mo. steel.

ONE OF 23 TIMKEN HIGH TEMPERATURE STEELS

Carbon	Sicromo 2	Sicromo 5S	16-13-3*
Carbon-Mo.	Sicromo 2½	Sicromo 5MS	25-20*
DM-2	2¼% Cr.-1% Mo.	Sicromo 7	25-12*
Silmo	Sicromo 3	Sicromo 9M	35-15*
DM	4-6% Cr.-Mo.	18-8 Stainless	16-25-6*
2% Cr.-Mo.	4-6% Cr.-Mo.-Ti.	18-8 Cb	

**Available as seamless tubing on an experimental basis only.*

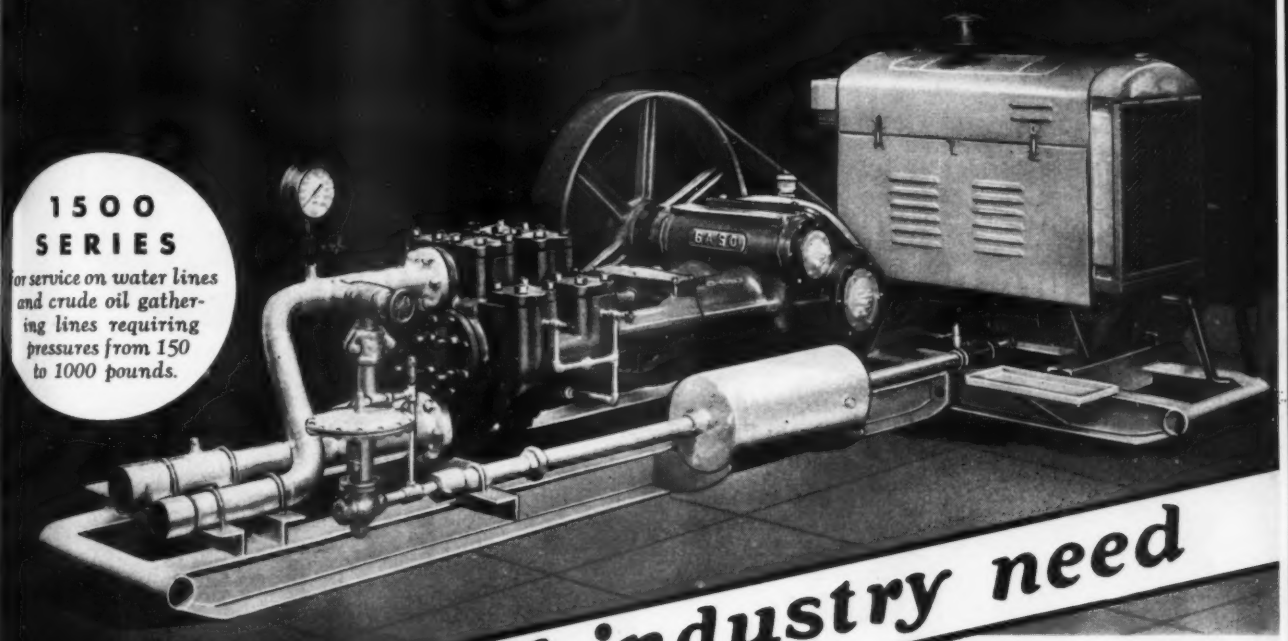
More than 20 years of research have made Timken the leading authority on high temperature tubing. Photo shows test for linear coefficient of thermal expansion.

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

Specialists in alloy steel—including hot rolled and cold finished alloy steel bars—a complete range of stainless, graphitic and standard tool analyses—and alloy and stainless seamless steel tubing.

The Best Advertisements of GASO PUMPS Are The Cost Records of Users!

GASO PUMPS



1500 SERIES
for service on water lines and crude oil gathering lines requiring pressures from 150 to 1000 pounds.

for every oil industry need

The pump is a standard Gaso Figure 1550—2½ to 5x10 inches, mounted on steel skids, with gas engine power. The *assembly* includes by-pass piping, bleeder pipe, gas regulator and reservoir for gas supply to engine . . . Assembled complete in the Gaso plant for quick installation in the field . . . Another example of the flexibility of Gaso service—directed by experience, tailored to the customer's needs and extending to all parts of the complete pumping unit. Ask for catalog.

GASO PUMP & BURNER MFG. CO.
TULSA, OKLAHOMA, U. S. A.
Export Office: 149 Broadway, New York. Shreveport and Odessa: W. L. Somner Co.
Los Angeles: Production Equipment Co., Inc. 2529 Chambers St., Vernon

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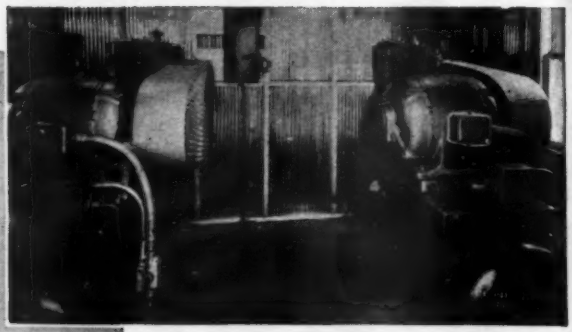


Above—Two 10 horsepower Century squirrel cage motors driving air compressors.

At left—7½ horsepower Century splash proof motor driving a pumping unit.

Century MOTORS for the Oil Industry

Assure Dependable, Economical Operation

Subjected to rain, snow, sleet and hail thousands of Century Splash Proof Type SCT High Torque High Slip Motors are operating producers' pumps—many for 18 years.

The high slip of the Century type SCT motor saves wear and tear on equipment because it slows down and cushions the impact of the peak load and reduces the sudden shock and its damaging effect.

Century builds a wide range of electric motors, in sizes from 1/6 to 400 horsepower, for oil producing and refining operations. Popular types and standard ratings are generally available from factory and branch office stocks.

Specify Century motors for all your electric power requirements. See your regular supply store.

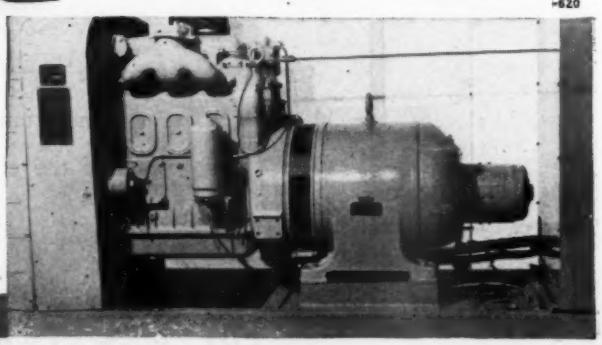
Illustrating Century splash proof and explosion proof motors.

CENTURY ELECTRIC CO.
1806 Pine Street • Saint Louis 3, Missouri
Offices and Stock Points in Principal Cities

H-620

Century Type ARC Generator

Where public service current is not available, Century Generators will provide adequate, continuous electric power. Depending on the load per motor and the size of generator, from 10 to 30 wells can be operated from one generator. They provide a dependable source of oil field power.



Ladish Elbows

...A Complete Size Range Another Reason to Specify *Controlled Quality*

SEAMLESS WELDING FITTINGS

From the small fitting that weighs several ounces to the half-ton giant . . . whatever your fittings requirement, the Ladish line provides you with an unrestricted choice of sizes in a complete range of types, weights and materials. In addition, every fitting offers the added dependability assured by the high manufacturing and metallurgical standards of Ladish Controlled Quality.

THE COMPLETE FITTINGS LINE
PRODUCED UNDER ONE ROOF...ONE RESPONSIBILITY

LADISH CO.

CUDAHY, WISCONSIN
MILWAUKEE SUBURB

DISTRICT OFFICES: New York • Buffalo • Pittsburgh • Philadelphia • Cleveland • Chicago
St. Paul • St. Louis • Atlanta • Houston • Los Angeles • Havana

XUM

Chemicals you live by

WE HELP SCRUB OIL PRODUCTS, TOO

A lot of DIAMOND ALKALI'S Caustic Soda helps make soap for scrubbing little boys' faces, but an increasingly larger amount of DIAMOND Caustic Soda flows into your refineries to help scrub gasoline and kerosene and for cleaning up petroleum fractions.

With the ever-growing emphasis on high quality and anti-knock values, caustic soda has become a chemical of prime importance to the refining industry.

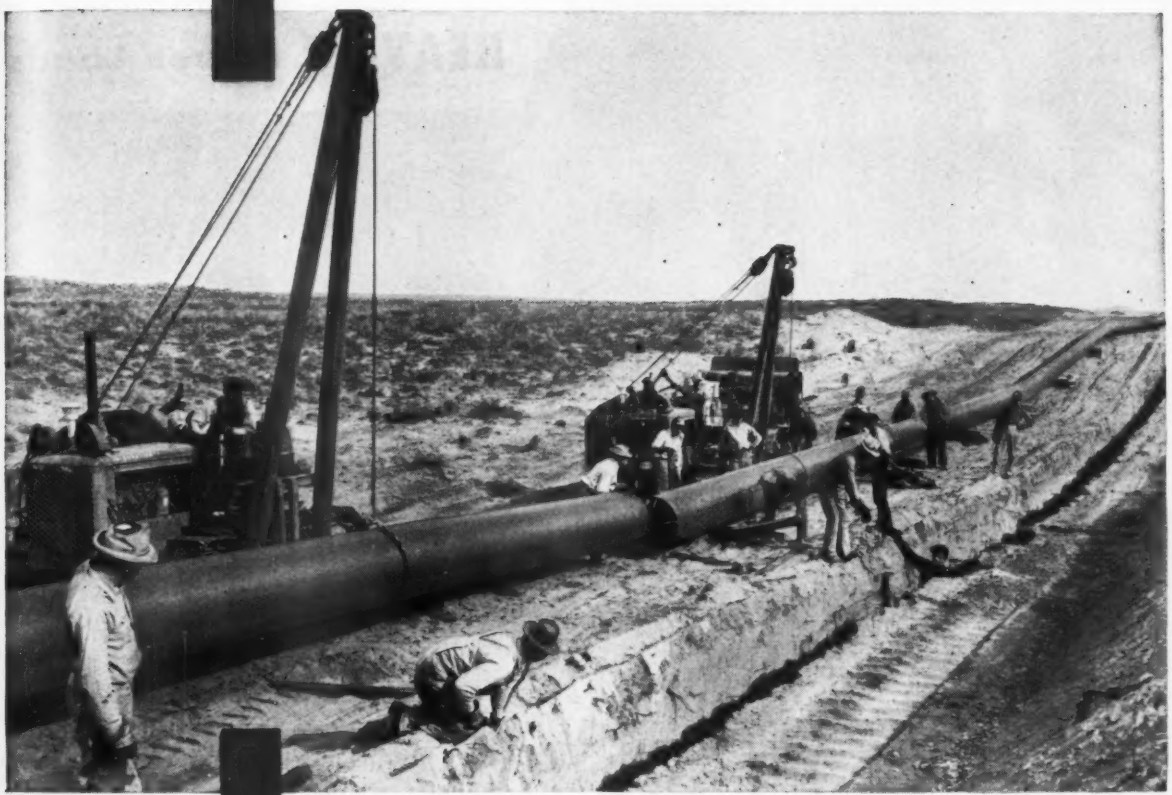
To help meet your need for caustic soda, DIAMOND ALKALI last year completed its newest (and largest) electrolytic chemical plant at Houston. This plant, in combination with DIAMOND'S other caustic-chlorine plants at Pine Bluff, Arkansas, Painesville, Ohio, and Edgewood, Maryland, provides the oil industry with a flexible, dependable and speedy source of supply of both chlorine and caustic soda.

DIAMOND CHEMICALS FOR THE OIL INDUSTRY

DIAMOND ALKALI COMPANY • CLEVELAND 14, OHIO

DIAMOND ALKALI CHEMICALS

DEPENDABILITY through RESEARCH and ENGINEERING



When A. O. Smith developed and introduced high-strength, resistance-welded line pipe in 1927, many contemplated projects of the oil and gas industry became technically—and financially—possible for the first time. Before 1927, total national, large-diameter pipe production was approximately 3 miles a day. New automatic machines soon increased A. O. Smith production to 30 miles a day, lengths were standardized, and pipe costs were cut almost 50 per cent. As a result, nearly every major pipeline is wholly, or in part, built of A. O. Smith Pipe.

Today *A. O. Smith Line Pipe, offering increased yield strength without increased weight, is available in a complete range of sizes and wall thicknesses, from 8⅝ in. to 30 in. diameter. Write for Bulletin No. 576.*

A. O. Smith Corporation • Atlanta 3 • Chicago 4
Dallas 1 • Denver 2 • Houston 2 • Los Angeles 14
New York 17 • Pittsburgh 19 • Salt Lake City 1
Seattle 1 • Tulsa 3 • Washington 6, D.C.
International Division: Milwaukee 1

A.O.Smith
LINE PIPE • CASING

A.O. Smith Steel 76th ANNIVERSARY 1874 1950

XUM

. . . Call for *Condor* V-BELTS

A big multiple V-Belt team, like that shown above represents an important cost of drilling. When you buy a team of V-Belts like this, you should get *all* the power you pay for to hold your drilling costs down. Higher rig floors and bigger pumps for deeper drilling demand longer, stronger V-Belts.

Manhattan engineers have developed the New Improved Condor V-Belt to save you money. They feature new strength members of stronger synthetic fiber cords, precision controlled on the neutral axis "Power Line" of the V-Belt.

In addition, the full molding pressurizing process developed at Manhattan virtually eliminates variation in V-Belt Balance. This means every Condor V-Belt runs smoother, pulls its share of the load easier than ever before.

Practically all inelastic stretch is removed during manufacture of Condor V-Belts, so that after they are installed, there are no laggards and no over-strained belts. Rugged sidewall construction and heavy-duty covers withstand wear and weather and protect the heart of the belt against premature failure.

Be sure to try the improved Condor V-Belts on your next replacement drive. Their longer service saves you money.

Manhattan also makes industrial V-Belts in Oil-Proof and Non-Spark Constructions.

"Keep Ahead with Manhattan"

MANHATTAN RUBBER DIVISION — PASSAIC, NEW JERSEY

RAYBESTOS-MANHATTAN, INC.

Manufacturers of Mechanical Rubber Products • Rubber Covered Equipment • Radiator Hose • Fan Belts • Brake Linings • Brake Blocks • Clutch Facings • Packings • Asbestos Textiles • Powdered Metal Products • Abrasive & Diamond Wheels • Bowling Balls

XUM

XUM

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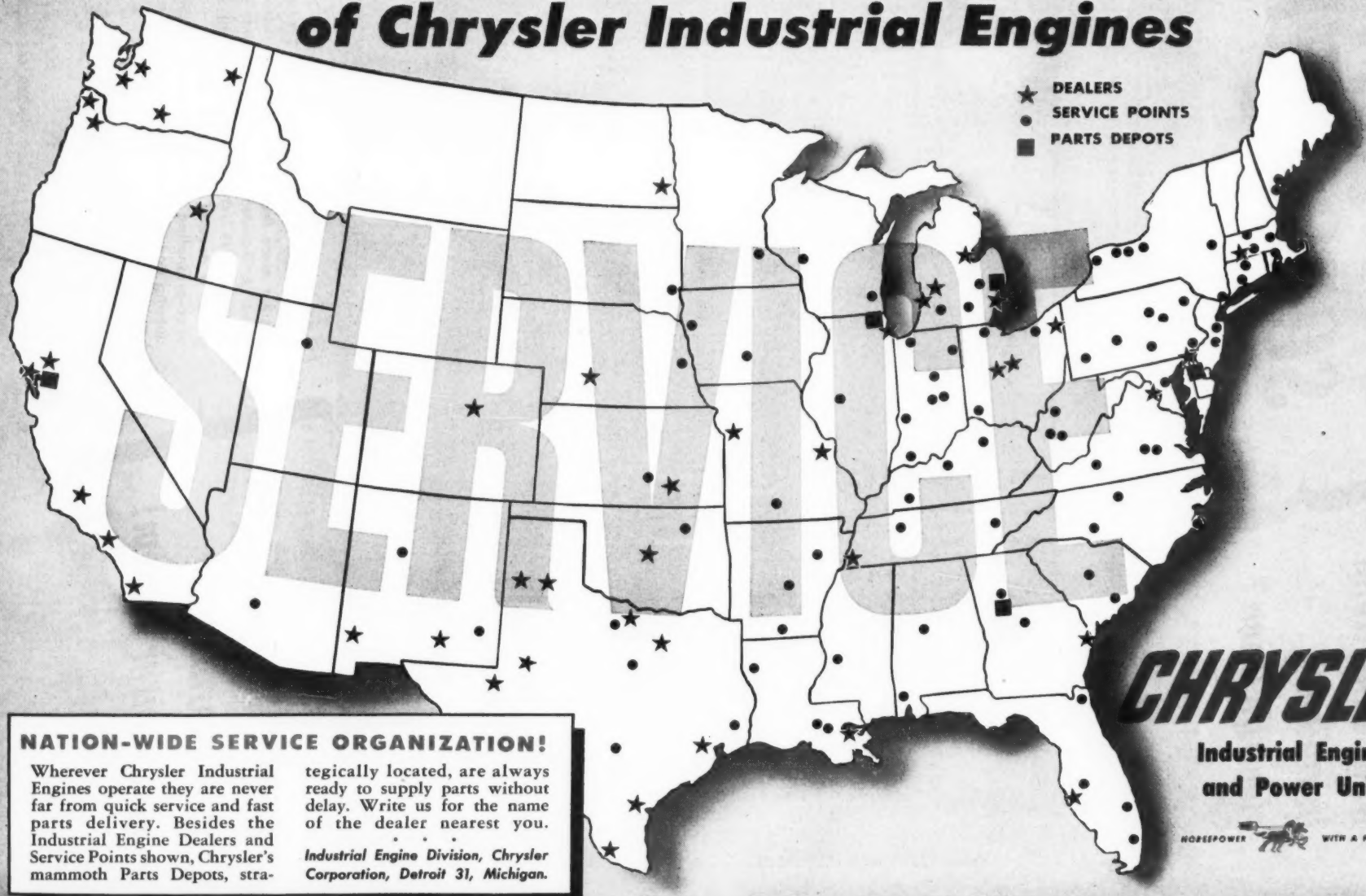
THE GREAT INVISIBLE FEATURE

of Chrysler Industrial Engines



NATION-WIDE SERVICE ORGANIZATION!

Wherever Chrysler Industrial Engines operate they are never far from quick service and fast parts delivery. Besides the Industrial Engine Dealers and Service Points shown, Chrysler's mammoth Parts Depots, strategically located, are always ready to supply parts without delay. Write us for the name of the dealer nearest you.

* * *

Industrial Engine Division, Chrysler Corporation, Detroit 31, Michigan.

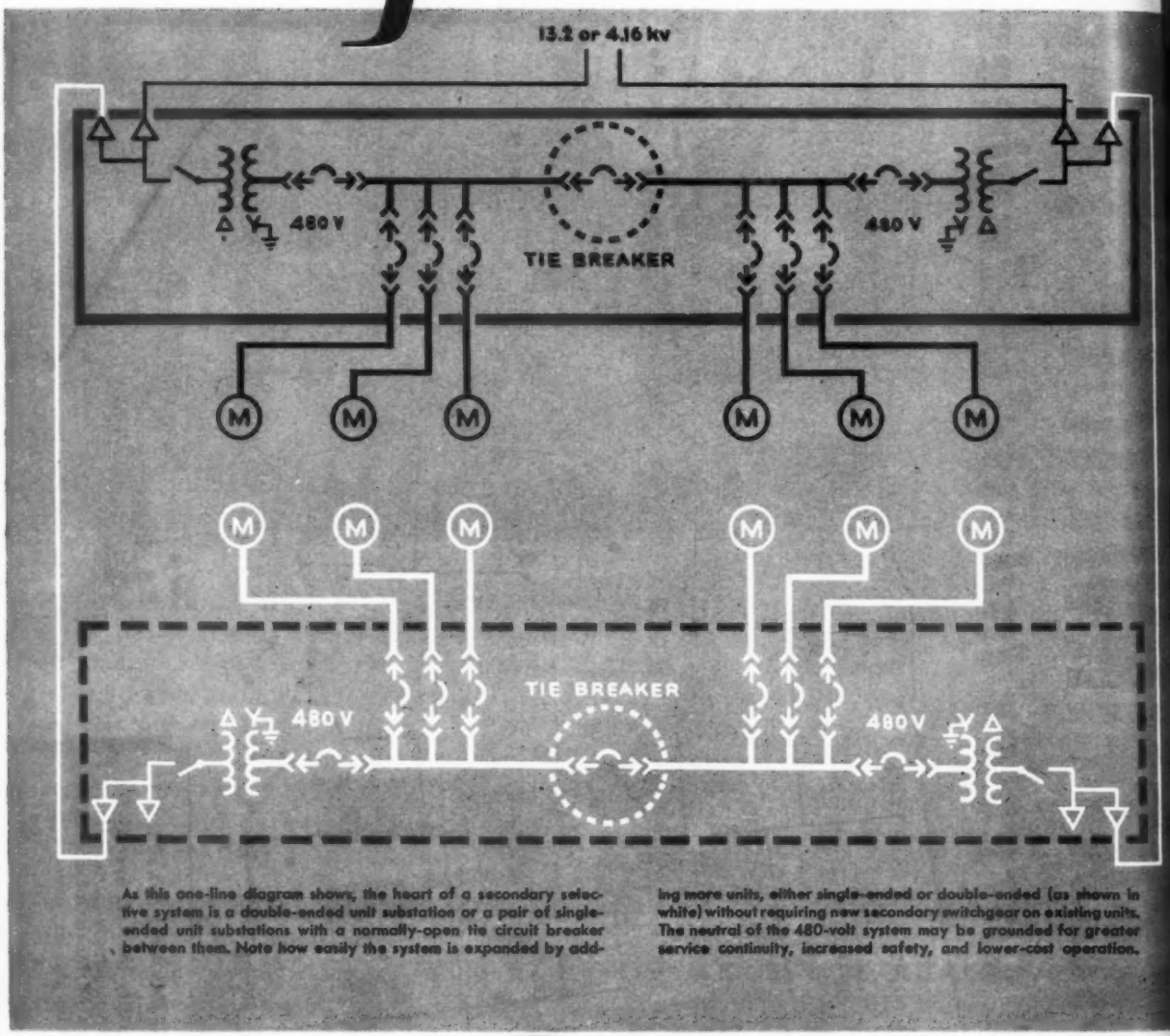
CHRYSLER

Industrial Engines and Power Units

HORSEPOWER WITH A PEDIGREE

What's the trend in refinery electrification?

secondary



As this one-line diagram shows, the heart of a secondary selective system is a double-ended unit substation or a pair of single-ended unit substations with a normally-open tie circuit breaker between them. Note how easily the system is expanded by adding more units, either single-ended or double-ended (as shown in white) without requiring new secondary switchgear on existing units. The neutral of the 480-volt system may be grounded for greater service continuity, increased safety, and lower-cost operation.

Here's what you need to modernize your power system!

WHEN YOU COME TO GENERAL ELECTRIC you get far more than the finest in electrical equipment. A General Electric application engineer, familiar with refinery practices, is at your disposal. If desired, he stands ready to assist you in co-ordinating all the needed components, engineering your power distribution into one modern, efficient system.

XUM

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selective distribution systems

WITH UNIT SUBSTATIONS

—to protect continuity of service at minimum cost

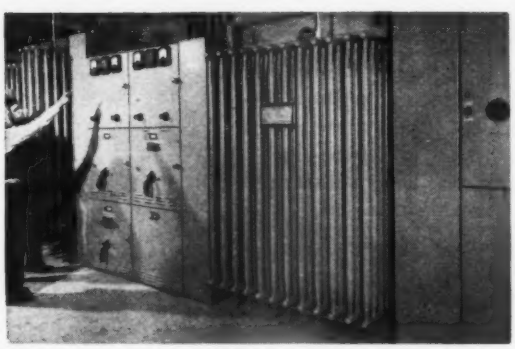
What's behind the growing refinery practice of distributing power through secondary selective systems? Primarily it's recognition of the fact that for most plants it provides a simple, low-cost way to safeguard service continuity for operations requiring uninterrupted production.

This method utilizes a normally-open tie circuit breaker between the secondaries of two transformers in a double-ended unit substation. The tie provides an alternate source of power for secondary circuits if either transformer becomes de-energized by a fault in the primary circuit. In effect, it enables one "partner" when necessary to carry the essential load.

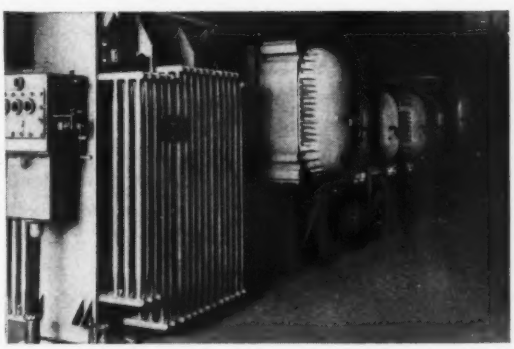
Simplicity is another advantage of this system. Operating personnel need no special training to operate and maintain the equipment contained in a double-ended unit substation—chiefly transformers and manually-operated drawout air circuit breakers.

Moreover, expansion is easy and economical. Single-ended or double-ended substations can be added at will. Since no added interrupting duty is imposed, no new secondary switchgear is needed on existing units. Full data is contained in Bulletin GET-1438, "Secondary Networks for Industrial Plants." Send for your copy today. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

TO HELP CUT YOUR POWER DISTRIBUTION COSTS . . . Don't miss seeing the "More Power to America" full color and sound slide-film "Modern Industrial Power Distribution." It's packed with helpful, cost-cutting ideas you can use. Ask your G-E representative to arrange a showing for your organization.



G-E double-ended load-center unit substations for non-hazardous areas are compact, factory-assembled "packages." Shipped ready to install, they are furnished in flexible combinations of incoming-line and secondary-circuit arrangements with transformers from 100 to 2000 kva.



For semi-hazardous areas, G-E double-ended load-center unit substations have easily removable air circuit breakers, each in Class I, Group D enclosures, plus primary power circuit breaker, a standard Pyranol® transformer section, and a secondary bus enclosure.

GENERAL ELECTRIC

661-12

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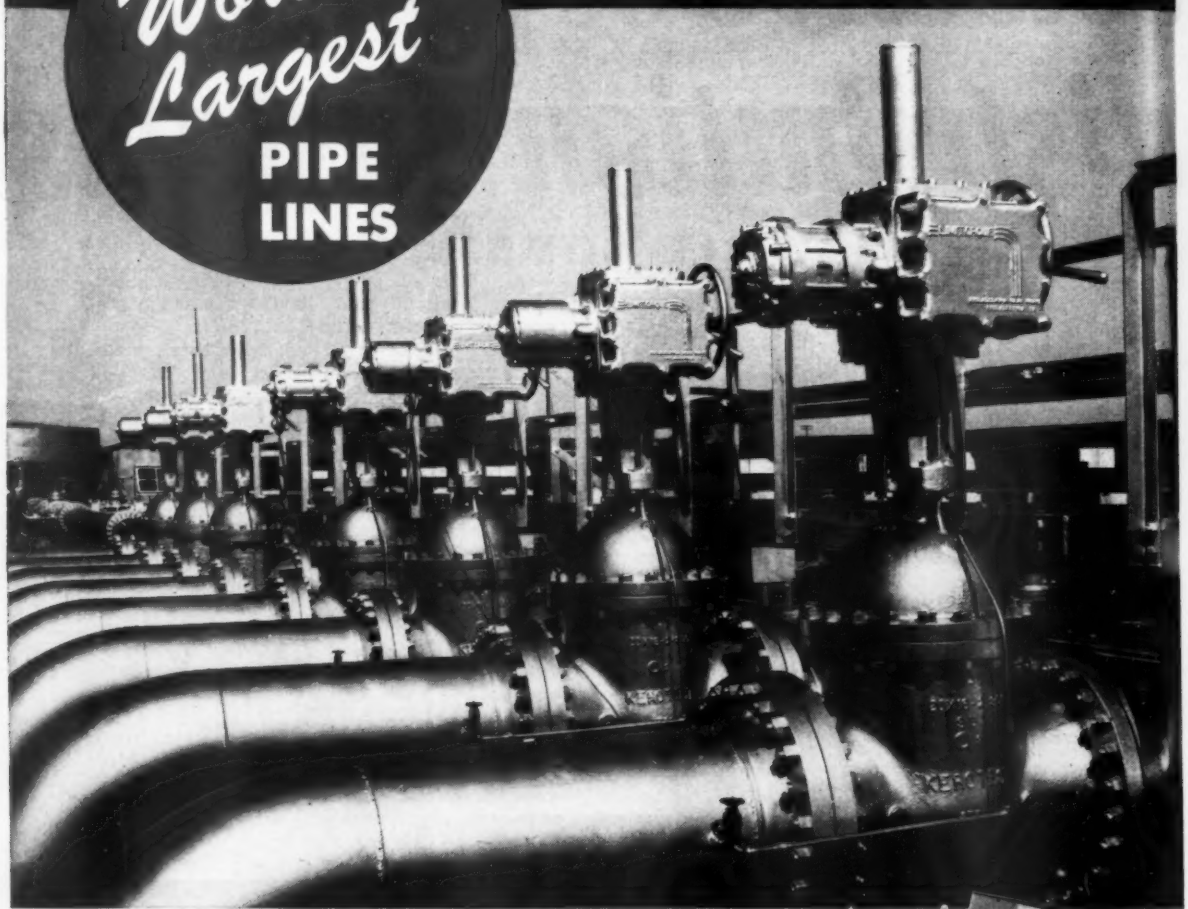
LIMITORQUE VALVE CONTROLS

ON THE *World's Largest* PIPE LINES



Hundreds upon hundreds of LimiTorque Valve Operators are used on Pipe Lines and in Refineries throughout the world, because they operate (at the mere "push of a button") . . . under the most severe conditions of Heat or Cold, Rain, Snow, Dust, Dirt or Fumes . . . night and day . . . year-in and year-out—LimiTorque *saves* time, labor and money by *eliminating manual operation* of valves at distant locations. It opens and closes valves at the *exact speed* required, and is *absolutely dependable and safe*. Also, as the name implies, LimiTorque *limits the torque* applied to valve operating parts, and thus *prevents damage* to stems, discs and seats, etc.

LimiTorque utilizes any available power source for operation: electricity, oil, gas, water or air. You take no chances with LimiTorque, because it has been tested and time tried under all conditions over a long period of years.

Please be sure to use your Business Letterhead when writing for this valuable illustrated Catalog.

Philadelphia Gear Works, INC.

ERIE AVE. AND G ST., PHILADELPHIA 34, PA.
NEW YORK • PITTSBURGH • CHICAGO • HOUSTON
IN CANADA: WILLIAM AND J. G. GREEY LIMITED, TORONTO

Industrial Gears and Speed Reducers
LimiTorque Valve Controls

Now! a FASTER·EASIER·SAFER way to handle pipe

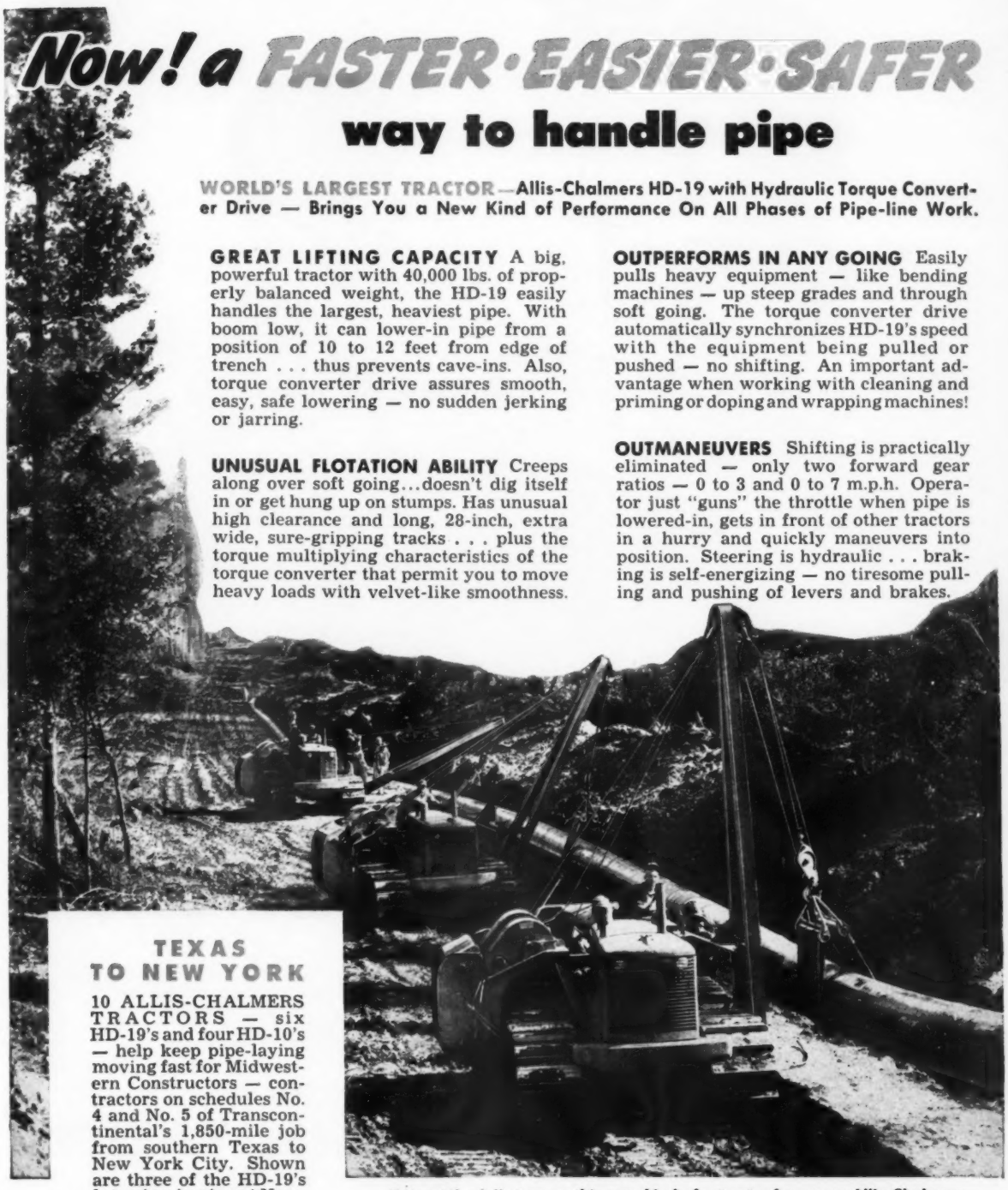
WORLD'S LARGEST TRACTOR—**Allis-Chalmers HD-19 with Hydraulic Torque Converter Drive — Brings You a New Kind of Performance On All Phases of Pipe-line Work.**

GREAT LIFTING CAPACITY A big, powerful tractor with 40,000 lbs. of properly balanced weight, the HD-19 easily handles the largest, heaviest pipe. With boom low, it can lower-in pipe from a position of 10 to 12 feet from edge of trench . . . thus prevents cave-ins. Also, torque converter drive assures smooth, easy, safe lowering — no sudden jerking or jarring.

UNUSUAL FLOTATION ABILITY Creeps along over soft going...doesn't dig itself in or get hung up on stumps. Has unusual high clearance and long, 28-inch, extra wide, sure-gripping tracks . . . plus the torque multiplying characteristics of the torque converter that permit you to move heavy loads with velvet-like smoothness.

OUTPERFORMS IN ANY GOING Easily pulls heavy equipment — like bending machines — up steep grades and through soft going. The torque converter drive automatically synchronizes HD-19's speed with the equipment being pulled or pushed — no shifting. An important advantage when working with cleaning and priming or doping and wrapping machines!

OUTMANEUVERS Shifting is practically eliminated — only two forward gear ratios — 0 to 3 and 0 to 7 m.p.h. Operator just "guns" the throttle when pipe is lowered-in, gets in front of other tractors in a hurry and quickly maneuvers into position. Steering is hydraulic . . . braking is self-energizing — no tiresome pulling and pushing of levers and brakes.



TEXAS TO NEW YORK

10 ALLIS-CHALMERS TRACTORS — six HD-19's and four HD-10's — help keep pipe-laying moving fast for Midwestern Constructors — contractors on schedules No. 4 and No. 5 of Transcontinental's 1,850-mile job from southern Texas to New York City. Shown are three of the HD-19's lowering-in pipe at Newnan, Georgia.

But get the full story on this new kind of a tractor from your Allis-Chalmers dealer. Let him give you a demonstration. "Seeing Is Believing."

There's a right size A-C tractor for every need

Model	Horsepower	Weight (bare)
HD-19	163.00 on flywheel	40,000 lbs.
HD-10	86.63 drawbar	21,000 lbs.
HD-7	60.10 drawbar	13,830 lbs.
HD-5	40.26 drawbar	10,500 lbs.

ALLIS-CHALMERS
TRACTOR DIVISION · MILWAUKEE 1, U. S. A.

Originator of the Torque Converter Tractor

XUM

We've never drilled an easy well that's why we always use NATIONAL SEAMLESS

● If you're like most oilmen, you've never actually had a well that was "easy to drill." When you come right down to it, they're *all* tough. To do a good job, and still keep costs in line, you have to know your stuff. And you have to use the very best equipment and materials.

That's why so many oil field men insist on National Seamless. They can count on tough joints and strong walls—all the way down. They know that, no matter how difficult the job, National Seamless will deliver an unbeatable amount of *service per dollar.*

To a great extent, our never-ending research program is responsible for the high quality of National Seamless. It's the same program that has consistently produced National Seamless Drill Pipe with stronger joints and faster running threads. It's the same program that developed National Warm Worked Casing, renowned for its high collapse resistance and greatly increased joint strength.

Utilize the immense background of information compiled by National Tube Company . . . world's largest manufacturer of tubular products. Write today for Bulletin 15, "Seamless Drill Pipe, Casing and Tubing." Address National Tube Company, Frick Building, Pittsburgh 19, Pennsylvania.

NATIONAL TUBE COMPANY, PITTSBURGH, PA.

UNITED STATES STEEL EXPORT COMPANY, NEW YORK

WALLS WITHOUT WELDS

USS

NATIONAL SEAMLESS

drill pipe . . . casing . . . tubing

UNITED STATES STEEL

XUM

QUICK ACCEPTANCE *in the gas transmission field!*

Pipe line companies purchase over 60 Worthington uniflo design TYPE UTC-16 angle gas engine compressors

It takes time — and actual working conditions — to show how equipment stands up. That explains the keen interest of transmission companies and refineries when the first commercial installation of Worthington's new Angle Gas Engine Compressor TYPE UTC-16, was dismantled for inspection. After 2763 hours of continuous operation — under full load and frequent overload — it was found that:

- **All parts were carbon-free,** demonstrating the marked superiority of Worthington uniflo scavenging over conventional loop scavenging for reducing wear.
- **Pistons and liners were still well within shop tolerances,** and the high polish on the entire liner surfaces indicated A-1 operating condition.
- Rings showed minimum wear, with tool marks still visible.
- Bearings were all in perfect condition.

A Success From The Start

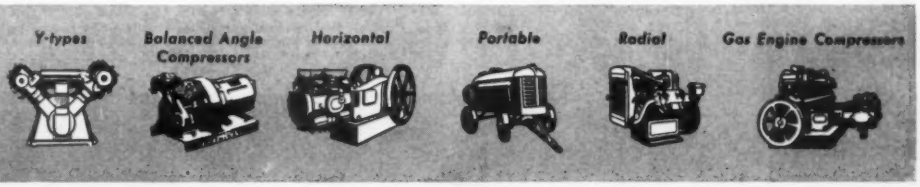
Shop tests had already proved TYPE UTC-16's more thorough scavenging, and perfect combustion. Now, this far more conclusive field test proved the ability to assure these benefits over a long, trouble-free service life. And a steadily growing list of purchasers has established TYPE UTC-16 as a real history-maker in the development of more efficient, more economical gas transmission.

Why not investigate the many advantages of joining this list? Get the whole story that proves *there's more worth in Worthington* from our nearest District Office. Or write to *Worthington Pump and Machinery Corporation, Engine Division, Buffalo, N. Y.*

WORTHINGTON

EX-6-3

NO OTHER COMPRESSOR WILL OUTPERFORM A WORTHINGTON



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Smith Meters cover the entire field of liquid measurement in the Petroleum Industry!

Crude Oil Measurement–Refineries–Pipe Lines –Loading Racks–Tank Trucks–A type and size for the widest range of flow rates and pressures. All built on the simple SMITH ROTARY PRINCIPLE, dependable, accurate and fast, *the design that revolutionized the meter industry.*

Smith High Pressure Meters use a double case design with the metering unit within a pressure case, thus eliminating all pressure distortion and providing for simple servicing of the measuring unit.

Available in three pressure ranges and five sizes. 250 p.s.i. to 1,000 p.s.i. 171 Bbls. per Hour to 929 Bbls. per Hour.

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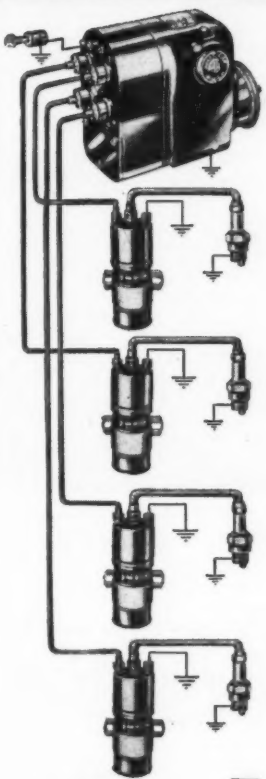
METER DIVISION

FACTORIES: 5715 SMITHWAY ST., LOS ANGELES 22, CALIF. • P.O. BOX 580, SUCCASUNNA, N. J.

Sales Offices: New York, Chicago, Houston, Los Angeles. *In Canada:* Toronto, Vancouver. *International Division,* Milwaukee 1, Wisconsin. Local Agents in All Principal Cities



A NEW LOW TENSION MAGNETO IGNITION SYSTEM FOR LARGE, SPARK IGNITED ENGINES!

The System comprises the new American Bosch MRB Low Tension, shielded Magneto with individual High Tension Ignition Transformers mounted at each engine cylinder (as shown in diagram of 4-cylinder installation at left). Low tension current, generated in the Magneto, is distributed through low tension leads to the Transformers where the electrical energy is converted to high voltage and conducted to the spark plugs by short cables—shielded if desired. The rugged, heavy-duty high tension Transformers are available with or without shielding (as illustrated) to suit specific installation needs, either in use in the new American Bosch Low Tension Magneto System or other low tension systems employing magneto or battery ignition.

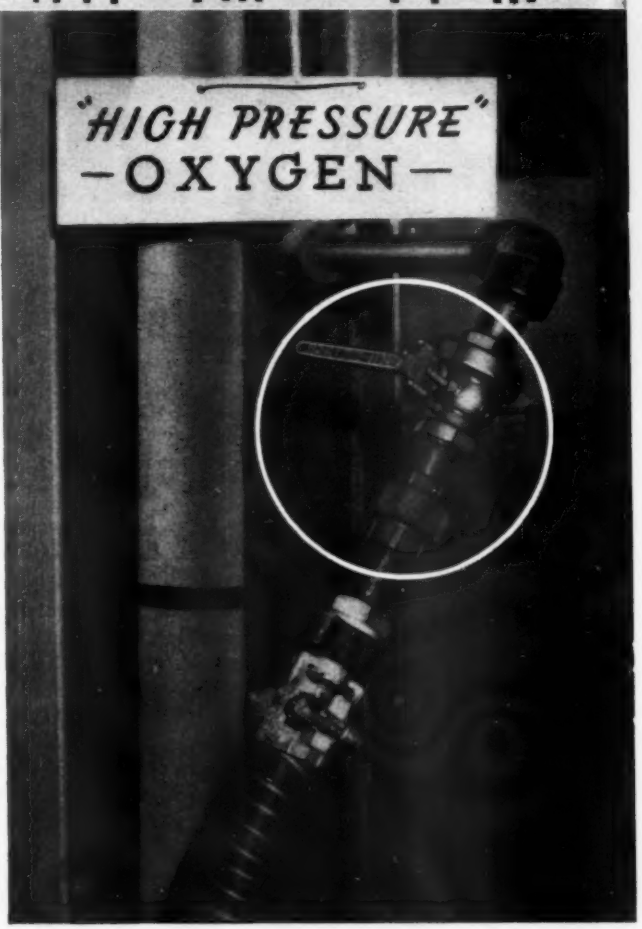
Energy losses and corona effects which occur with long high tension cables are eliminated in this new, versatile Low Tension System. The possibility of fire and explosion hazard is minimized where engines operate in combustible oil or gas vapors . . . radio and television interference may be greatly reduced by complete shielding. These important operating advantages, combined with the outstanding electrical and mechanical features of the new American Bosch Low Tension Magneto offer maximum spark efficiency under the severest conditions for your large bore stationary engines. Write for the facts and we'll show you how you can get this high standard of performance and safer, continuous operation on your present equipment.

American Bosch

MAGNETOS • GENERATORS • VOLTAGE REGULATORS • IGNITION COILS
ELECTRIC WINDSHIELD WIPERS • DIESEL FUEL INJECTION EQUIPMENT

AMERICAN BOSCH CORPORATION • SPRINGFIELD 7 • MASS.

ROCKWOOD BALL VALVES HELP INCREASE STEEL MAKING CAPACITY



No place for leaky valves on this high pressure oxygen line where careful control of the flow of oxygen to the open hearth furnaces is necessary at all times.

The Rockwood Ball Valve was selected by this large steel corporation primarily for its quick turn on and off action and leak proof service. These outstanding features of the Rockwood Valve enables furnace operator to properly control the oxygen which is used for the melting process that helps increase furnace capacity.

The seven features on the right are the secret of Rockwood Ball Valves' dependable service — why you can count on them to stay on the job indefinitely without leaks or maintenance. Industry after industry has found Rockwood Valves reliable — in oil refineries, food, paper, chemical and rubber plants, etc.

You can have Rockwood Valves in bronze in all pipe sizes from ½" to 2" for 300 p.s.i. working pressure.

Additional information and uses will be promptly supplied — write for Bulletin V-4.

Distributors in all principal cities.

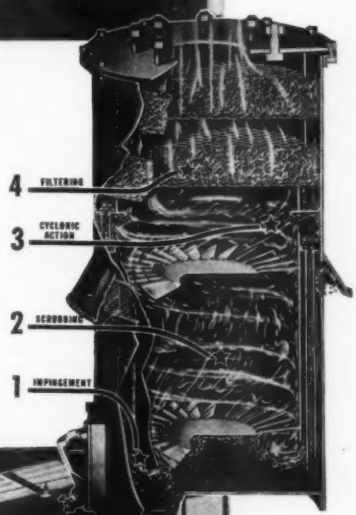
1. **Full round open area - no turbulence in fluid stream.**
2. **Leak proof after continued use.**
3. **New floating ball - resists pitting, scratching & abrasion.**
4. **No exposed seating surface in open or closed position.**
5. **Easy to open or close under full pressure.**
6. **Installed in any position.**
7. **Quarter turn (90°)opening and closing valve.**

ROCKWOOD SPRINKLER CO

104 HARLOW STREET WORCESTER 5, MASS

let it snow!

this Cycoil is indoors out of the weather



Cycoil Oil Bath Air Cleaner provides 4 way cleaning — Impingement, Scrubbing, Cyclonic Action and Filtering.

Filtration through Double Cells completes cleaning action eliminating oil mist from air.

Cyclonic action induced by vanes throws oil containing dust outward.

Scrubbing action, thoroughly mixes air and oil, entraining all dust particles.

Impingement of dirty air against oil, deposits the heavier dust particles immediately. Oil and air mixture then passes upward with whirling motion through vanes to succeeding cleaning steps.

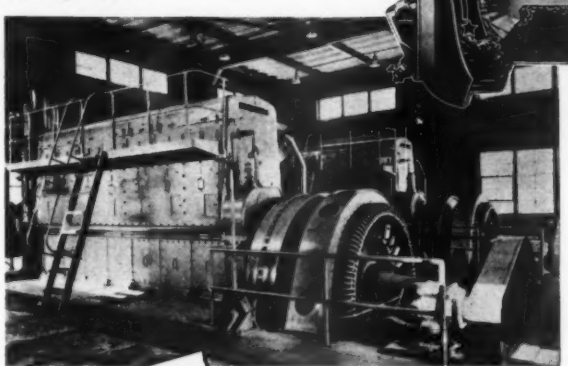
THIS Cycoil* at the Milford, Maine plant of Bangor Hydro-Electric Company has a tangential intake and is housed indoors for cold-weather protection. This type of intake keeps oil flowing when the mercury indicates "no-pour" temperatures. Cycoil is adaptable to many conditions—maintains steady year 'round function to protect costly engines.

With Cycoil, these Nordberg Diesels have the best known protection for uninterrupted service. AAF's Cycoil cleans the intake air for diesels in 4 ways, as explained in the drawing above. Its oil bath and cyclonic action removes more than 90% of all dust by oil immersion. Intense centrifugal action captures dust particles even before the air is filtered. Positive oil circulation maintains a self-cleaning action. Final air cleaning by filter pads in a double cell design offers nearly 100% dust elimination. For large dust-handling capacity, AAF's Cycoil has no equal. Just ask a diesel engineer.

Whatever your problems with air, to protect engines for continuous operation, call upon AAF's air experts.

For engineering details and complete explanation of performance standards on Cycoil write for Bulletin 130-E.

*Oil bath air cleaner



These 1425 H.P. Nordberg Diesels breathe the world's cleanest air, made that way by AAF—the world's greatest name in air cleaning.

Today's Best Buy is Better Air!

American Air Filter
COMPANY, INC.
444 Central Ave., Louisville 8, Ky. • *In Canada:* Darling Bros., Ltd., Montreal, P. Q.

XUM

Don't risk decay— use clean

PENTA-PROTECTED Wood

pentachlorophenol

Long lasting— will not Leach!

ON MARINE PLATFORM LUMBER . . .

Don't take chances with wood decay! Use PENTA-treated wood and know you're safe. PENTA-protection is effective protection against both decay and wood-attacking insects. PENTA-PROTECTED wood is clean, easy to handle, and lasts for years. The low water solubility of PENTAchlorophenol prevents leaching under the most adverse conditions.

Ask your lumber supplier for PENTA-PROTECTED wood. For more complete information write Dow, Dept. PE-32 A.

THE DOW CHEMICAL COMPANY • MIDLAND, MICHIGAN

DOW

penta-

chlorophenol

Pipe cut and beveled in ONE operation

. . . Fast . . . Accurate . . . Economical

This Magnolia Airco Pipe Beveling and Cutting Machine provides the fastest and most economical method of preparing pipe for welding. It is quickly adjustable for any bevel or straight edge cut and leaves pipe ends clear and free from burrs, slag and scale.

When equipped with two torches, the machine provides a speedy way to cut out frozen fittings, and simultaneously bevel the pipe for rewelding. No power is needed. Either the pipe is turned or is held stationary. In either case, the turning of a crank, as shown here, causes the machine to travel around the pipe. It is light enough to be carried and set-up by one operator.

Magnolia Airco Testing Machine for quick, accurate weld tests

The Magnolia Airco Portable Tensile and Guided Bend Testing Machine permits rapid testing of weld specimens in shop, laboratory or in the field. An outstanding advantage of this machine is its ability to perform not only the longitudinal all-weld metal and reduced section transverse tension tests, but also guided bend tests. An auxiliary hand on the gauge stops at the point on the dial where breakage occurs.

The machine is sturdily constructed and works on the hydraulic principle. Test loads up to 150,000 p.s.i., or higher, may be applied by selection of proper cross-sectional area of test specimen.

• • • • •

Catalog ADC 640 gives more information on the two machines illustrated here, as well as the rest of the complete, comprehensive Magnolia Airco line. If you would like a copy write to Dept.PX-8275, Magnolia Airco Gas Products Company, General Offices, Houston 1, Texas.

AIRCO AIR REDUCTION MAGNOLIA COMPANY

A Division of Air Reduction Company, Incorporated

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Southwestern Headquarters for Oxygen, Acetylene and Other Gases . . . Carbide . . . Gas Welding and Cutting Machines, Apparatus and Supplies . . . Arc Welders, Electrodes and Accessories

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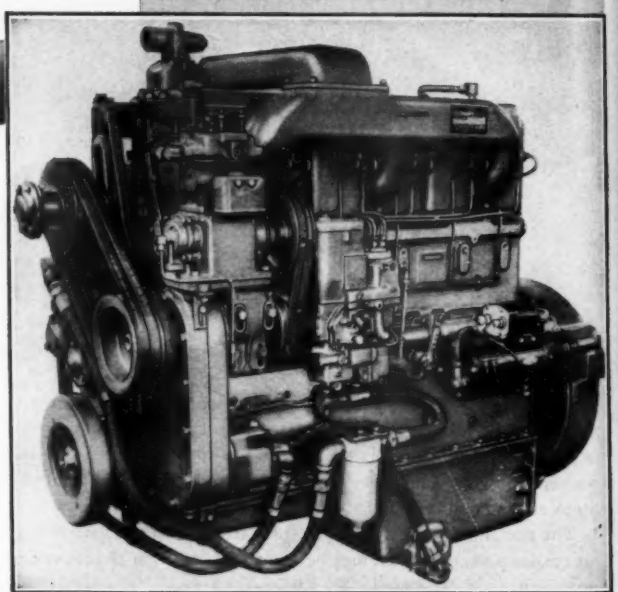
FLEXIBLE HOSE LINES

WITH DETACHABLE, REUSABLE FITTINGS

Always first
ON DIESEL ENGINES



Save time, save money and reduce inventory by putting the "Aeroquip Idea" to work for you. With Aeroquip you make your own flexible hose assemblies by cutting bulk hose to desired lengths and attaching Aeroquip Reusable Fittings. Assembly can be accomplished quickly and easily right on the job. No special tools are required. No training is needed. Aeroquip high quality Flexible Hose Lines improve performance and reduce maintenance. They eliminate leaks due to vibration and operate dependably at extremely high or low temperatures. They are widely used for hydraulic fluid, water, air, lubricating oils, gas and Diesel fuels and many other fluids.

Always first

B.D. check into this money saving idea—Joe

Because this Diesel Engine is plumbed with Aeroquip Flexible Hose Lines, replacement of any fluid-carrying line can be accomplished in a fraction of the time required for forming and fitting rigid tubing. Aeroquip Hose Lines are fire resistant and eliminate failure due to vibration.

AEROQUIP CORPORATION

JACKSON, MICHIGAN

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AEROQUIP PRODUCTS ARE FULLY PROTECTED BY PATENTS IN U. S. A. AND ABROAD

XUM

in construction

these men are at home 'round the world

turn page . . .

XUM

The Lummus construction superintendent and field engineer averages a twelve-year record of refinery building, literally—"everywhere under the sun." In addition, he has seen service at chemical plants and other heavy construction both in this country and abroad.

In a period of rapid progress, he has contributed to new techniques: the pre-assembly of pipe and equipment before erection, the raising of heavy vessels to greater heights and the providing of means to facilitate future maintenance and "turn around." Refinements in the scheduling of the erecting sequence are an outgrowth of his experience.

Behind Lummus' "ahead of time" deliveries stands the Construction Man. Because he has learned to *anticipate* the problems of remote location, emergencies seldom arise. But the records show that his decisions, made on-the-spot to meet the unexpected, reveal sound judgement and a steady hand. The low labor turnover, reflecting the high morale of his crews, both American and native, is evidence of his human as well as his technical understanding.

During the war he constructed, in record-breaking time, ordnance plants, high octane gasoline plants and plants that produced the raw materials for synthetic rubber. Today, the Lummus Construction Man is combining *time savings* with *dollar savings* in new projects throughout the world.

THE LUMMUS COMPANY
385 Madison Avenue, New York 17, N. Y.

LUMMUS

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HOUSTON—Mellie Esperson Bldg., Houston 2, Texas
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Société Française des Techniques Lummus
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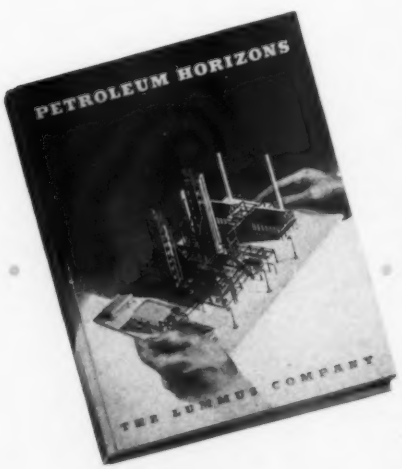
Esquina Las Gradillas, Caracas, Venezuela

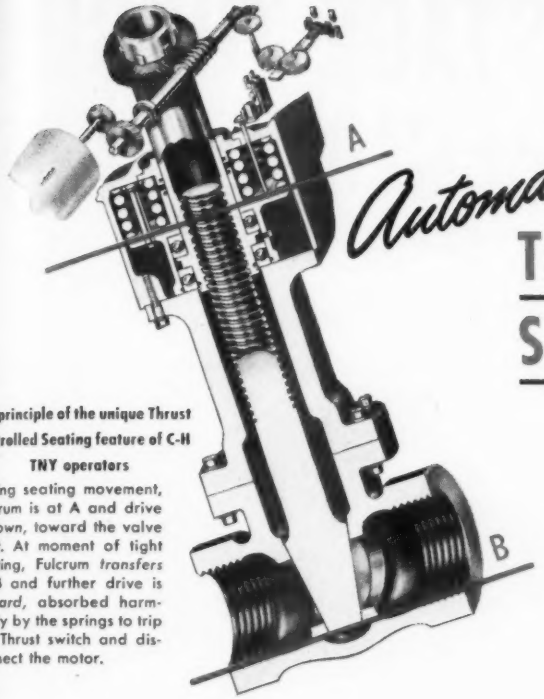
OIL STEEL CHEMICAL



This new eighty page book describes the latest process developments in petroleum refining.

Detailed descriptions and flow charts of more than thirty refinery processes are featured. Photographic techniques are employed to assist you to visualize units. Send for your copy—today.

XUM



The principle of the unique Thrust Controlled Seating feature of C-H TNY operators

During seating movement, Fulcrum is at A and drive is down, toward the valve seat. At moment of tight seating, Fulcrum *transfers* to B and further drive is *upward*, absorbed harmlessly by the springs to trip the Thrust switch and disconnect the motor.

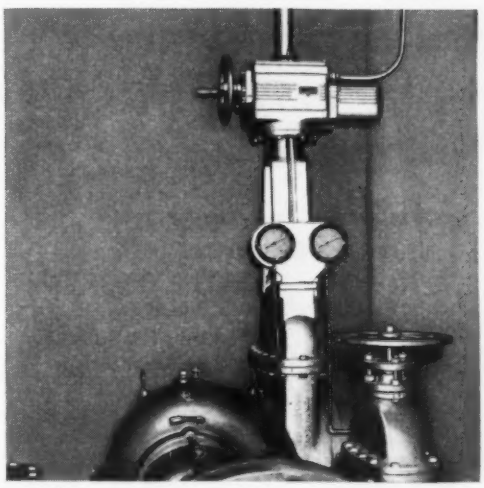
Automatic Valve Operation?

Thrust Control makes it Safe and Accurate, too!

IN THE petroleum industry, automatic, instant and swift motorized valve operation is an economic "must." Distance, difficulty, frequency of operation and danger are factors that urge such a step.

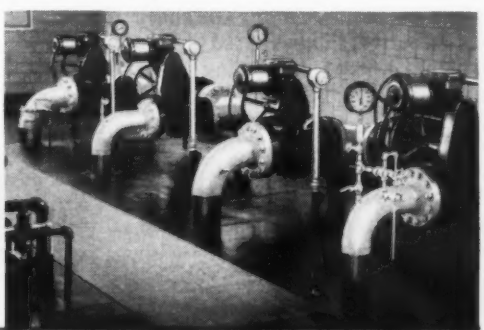
But the problem is also one of *accurate* and *safe* seating . . . as assured by the Thrust Control principle employed exclusively in Cutler-Hammer Valve Operators. The motor *positively* drives the valve disc home. During the driving period, the fulcrum is established at the yoke nut by heavy steel springs which exactly balance *tight seat pressure*. Therefore, at the very instant of desired tight seating, the driving fulcrum transfers to the seat of the valve, hence any further drive is into the yoke nut, against the heavy springs which harmlessly absorb motor drift. The movement of the yoke nut against the springs trips the *THRUST* switch to disconnect the motor. The amazing part is that the same degree of tight seating is maintained no matter how much valve parts may expand or contract. No other valve operator has or can have this direct *THRUST* controlled feature. No other valve operator can be as safe and sure and accurate. CUTLER-HAMMER, Inc., 1453 St. Paul Avenue, Milwaukee 1, Wisconsin.

CUTLER-HAMMER
VALVE CONTROL
C-H

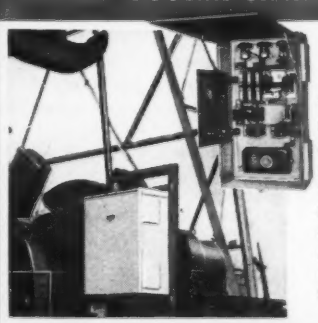


Exclusive Cutler-Hammer Thrust Control Valve Operators from few pounds thrust up to 80 TONS can be applied to any gate valves in the petroleum industry.

For valves which do not seat, such as the plug type valves, C-H B2 automatic declutching valve operators act swiftly and stop instantly.



OTHER CUTLER-HAMMER PRODUCTS FOR THE OIL AND GAS INDUSTRY



Long-lasting control that "schedules" oil well pumping

This Cutler-Hammer Motor Control Device built to the rigid requirements of tough oil country service automatically starts pump going and shuts it down in synchronization with oil well capacity or in conformity to operating schedule. You can set up any sequence of day and night operation, set it to skip certain days. Bulletin 9589D-21 tells all about this amazing pumping control. Send for free copy.

Know what you are buying, selling, giving away

These "gas counting" instruments tell you accurately

Cutler-Hammer Calorimeters . . . standard wherever gas is bought or sold—actually count the B. t. u.'s per cubic foot of the gas you are sending or receiving. Accurate within 1%. They also write a continuous 24-hour a day permanent record so you know at all times exactly what is going through your piping system . . . for accurate accounting and billing, and for accurate control of gas heating value. Free booklet "Where Experience Counts" tells all about C-H B. t. u. Control.

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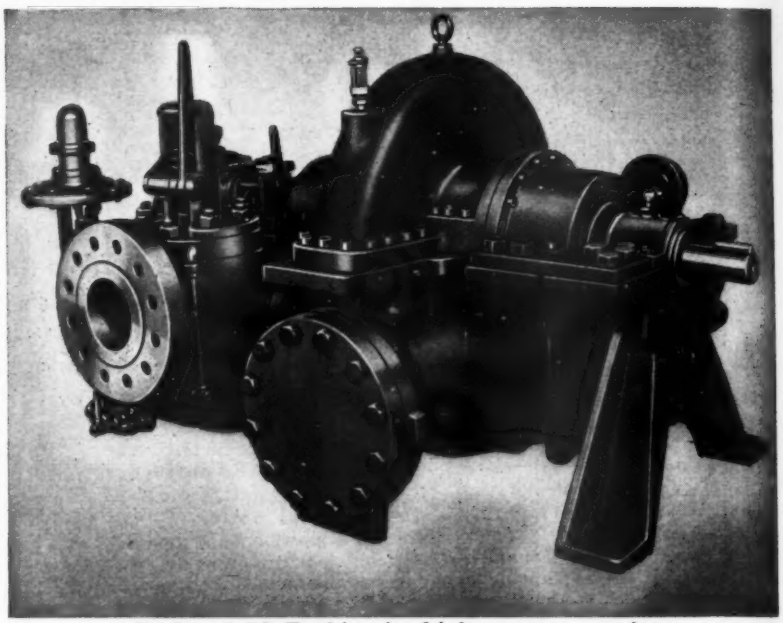
A NEW SINGLE-STAGE TURBINE DESIGNED ESPECIALLY FOR HIGH PRESSURES...

Initial pressures to 1450 psig .. Back pressures to 300 psig



De Laval CP Turbine for high pressure service.

THE FIRST SINGLE-STAGE TURBINE WITH ALL-LABYRINTH SHAFT SEALING

This new, high pressure single-stage turbine is more than an ordinary single-stage turbine in a "beefed up" high pressure casing. It is the *first* single-stage, mechanical drive turbine with all labyrinth shaft seals of the type generally used in large, multi-stage turbines especially designed for high pressure service.

Steam leakage along the shaft is effectively prevented by a labyrinth seal consisting of a series of shaft grooves and mating tongues of stainless steel—as many as 52 labyrinths per side being employed for the highest pressures. The labyrinth seal reduces losses, lasts longer and require less maintenance than carbon rings subject to wear.

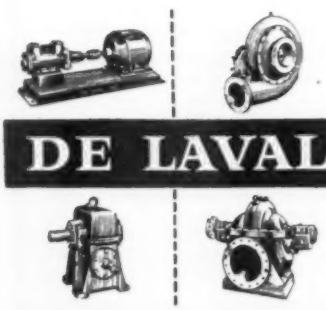
When you buy a De Laval CP Turbine you also get...

True center-line support—to provide for thermal expansion without disturbing shaft alignment.

Choice of eight governing systems—to meet every control requirement.

Independent, positive over-speed trip entirely independent of the governing system for positive protection.

Horizontally split casing with steam chest in bottom half. The cover can be lifted without disturbing piping connections.



The De Laval CP Turbine is made in three sizes for capacities up to 2000 hp. For further information write for Bulletin 4215-33A-OG.

DE LAVAL

DE LAVAL STEAM TURBINE COMPANY, TRENTON 2, N. J.

TURBINES • HELICAL GEARS • CENTRIFUGAL BLOWERS AND COMPRESSORS
CENTRIFUGAL PUMPS • WORM GEAR SPEED REDUCERS • IMO OIL PUMPS

T-33A

BIG PUSH FOR BIG INCHERS

HAVE YOU SEEN THE PIPELINER MOVIE?

Your Thew-Lorain Distributor will gladly arrange a showing of this new movie — packed with scenes on pipeline jobs across the country. Write for his name today.

LORAIN "PIPELINER JUNIORS" SET THE PACE ON 1000 MILE MID-VALLEY PIPELINE JOB . . .

Here goes 1000 miles of pipeline! It's the big Mid-Valley Pipeline Company job . . . threading its way through every kind of obstacle from Texas to Ohio.

BRITTON CONTRACTING CO. landed the contract for a tough 150 mile section in the vicinity of Russellville, Kentucky . . . and they picked new Lorain "PIPELINER JUNIORS" to blaze the trail for the 20 to 22 inch pipe. Britton has put the " O.K." on Lorain "PIPELINER JUNIORS" six times — proof that these machines answer the need of pipeline men.

"PIPELINER" FEATURES that pay off are many . . . extra-wide crawlers (11 ft. 8 in.) enable the "PIPELINER JUNIOR" to straddle ditches as they dig . . . with plenty of clearance to prevent cave-ins . . . plenty of width to move on and off the ditch. Special "Pipeline" dipper digs a clean, vertical wall. They're built for pipeline duty!

TWO "PIPELINER" SIZES to fit your job needs — a "PIPELINER JUNIOR" and "SENIOR" model — with exclusive Lorain features for pipeline work. Investigate — learn why users like Britton Contracting Co. are six-time "PIPELINER" owners! See your Thew-Lorain Distributor for all the facts!

THE THEW SHOVEL CO., LORAIN, OHIO

THEW® LORAIN PIPELINER

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A TERRIFIC HIT!

BETTER MECHANICS PREFER

TOLEDO 1R THREADER

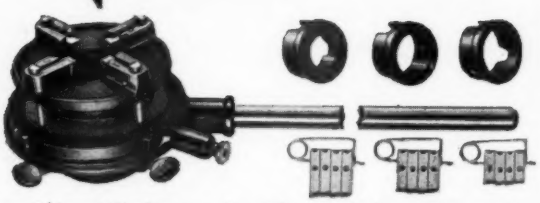
FOR 1" to 2" PIPE

because

It's ACCURATE!
Perfect threads produced by separate Toledo Dies for each pipe size.

It's EASY THREADING!
Less friction due to famous Toledo receding die principle—small die segments with only a few cutting teeth backed by taper pins.

It's LOW COST!
Simple in design with one ratchet handle.



Do your next 1" to 2" pipe work with a Toledo 1R Threader—the tool that's "tops" with better mechanics! Similar to the famous No. 1 and No. 1A Toledos—but *simpler in design* with one ratchet handle and *low in cost!* A separate set of dies for each size of pipe—1", 1¼", 1½" and 2"—assures longer die life. Each set is hobbed for just the proper clearance. This means easier cutting, smoother, cleaner, more perfect threads and tighter pipe joints! Die change is quick and easy . . . or, many users prefer separate tool for each size. Durable . . . saves job-time . . . reduces costs! Ask your distributor for details and price . . . or send coupon.

SEND COUPON

The Toledo Pipe Threading Machine Co.
Toledo, Ohio
Without obligation, send bulletin No. 650 and price on Toledo No. 1R Threaders, 1" to 2" pipe.

Name.....
Firm.....
Street.....
City.....State.....

RELY ON THE LEADER **TOLEDO**

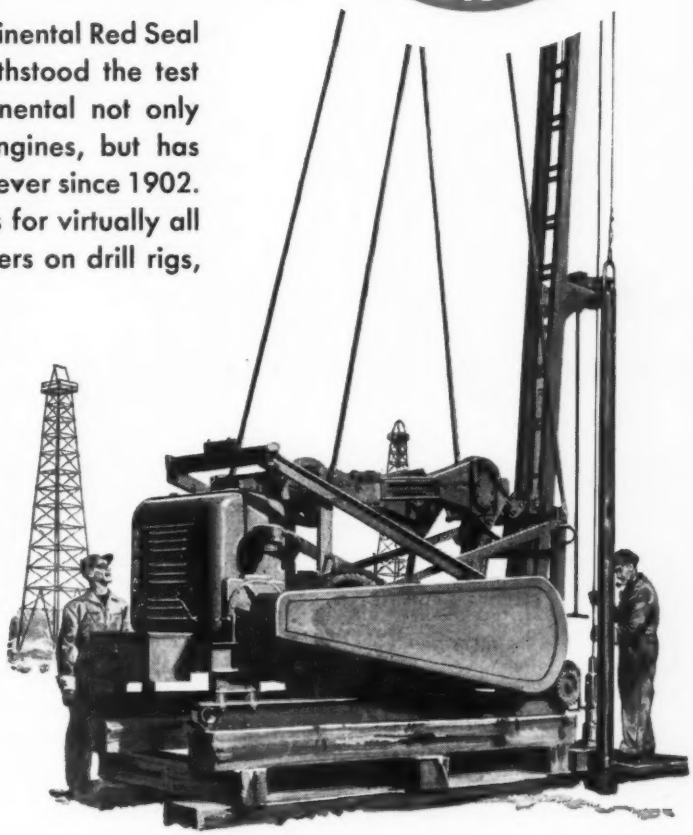
PIPE TOOLS . . . POWER PIPE MACHINES . . POWER DRIVES

CONTINENTAL RED SEAL POWER

...TIME-TESTED ENGINEERING FOR EVERY OIL FIELD APPLICATION

CONTINENTAL MOTORS ★ Powerful as the Nation ★ AMERICA'S STANDARD

One big plus value you get in Continental Red Seal power is engineering that has withstood the test of many, many years. For Continental not only pioneered internal combustion engines, but has paced the industry's development ever since 1902. Today, there are Red Seal models for virtually all oil field applications—prime movers on drill rigs, for workover rigs, winches, mud pumps, transfer pumps, auxiliary drilling equipment, and as standby power for generators, pumps and processing equipment. They're available for use with all standard fuels, and they're backed by a parts and service network reaching from coast to coast.



SEE OUR CATALOG IN COMPOSITE CATALOG

YOU MAY NOT NEED SERVICE FOR YEARS, BUT IT'S GOOD TO KNOW THAT WHEN YOU DO, IT'S AS NEAR AS YOUR PHONE

Continental Motors Corporation
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DARLING VALVES

FOR PLUS VALUES, JOB-PROVED AGAIN AND AGAIN

High Score FOR GOOD BEHAVIOR

IF you could check the performance of the thousands of Darling gate valves in oil country use, you'd agree that Darlings make a habit of exceptionally *good* behavior. It's largely a matter of *principle* . . . applied with equal advantage to Darlings from the smallest size to the largest motor-operated pipe line valves. Shown above, for example, are 12- and 16-inch Darling gate valves on water circulating pumps serving a natural gasoline plant.

In the cutaway view you can see the design that cuts out faulty operation and minimizes maintenance—the Darling fully revolving, double disc, parallel seat principle. Just four simple working parts—two interchangeable no-pocket discs and two husky wedges—but they add up to a whale of a difference in service life and over-all operating cost.

We'd like nothing better than to give you *all* the facts on how this principle provides automatic adjustment for valve body distortion and assures positive, easy closing . . . how it eliminates disc-to-seat galling, and distributes wear uniformly.

DARLING VALVES FOR EVERY NEED

Darling parallel seat gate valves (as well as taper seat wedge type) are available in a wide range of sizes and constructions for all kinds of normal and unusual service, and for pressures up to 1500 pounds.

Corrosion resistant types include iron body, plain or rubber lined, with special alloy trim, all bronze, all special alloy, or combinations as required.

ASK FOR BULLETIN

Darling's latest valve bulletin is full of helpful information and describes Darling valves of *all* types for every normal or unusual service.

DARLING VALVE & MANUFACTURING CO.

Williamsport 1, Pa.

Here's GOOD SOUND PIPE *for distribution lines*

Bethlehem Oil and Gas Pipe meets the needs of the oil and gas industries for welded steel pipe for distribution lines because it's made with exacting care to Specifications API-5Lx42, ASTM A139, or ASTM A134.

It comes in diameters from 22 in. up to the largest permitted by shipping clearances, and in 40-ft lengths. Sizes up to 36 in. diameter are furnished with one longitudinal and one girth seam; sizes greater than 36 in. diameter have two longitudinal seams. Bethlehem Oil and Gas Pipe is welded by the automatic submerged-arc process, and can be furnished with either beveled or square ends. Our modern shop facilities include grit blasting, priming, enameling and wrapping.

For complete details about the advantages of Bethlehem Oil and Gas Pipe, call the nearest Bethlehem sales office, or get in touch with us at Bethlehem, Pa.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

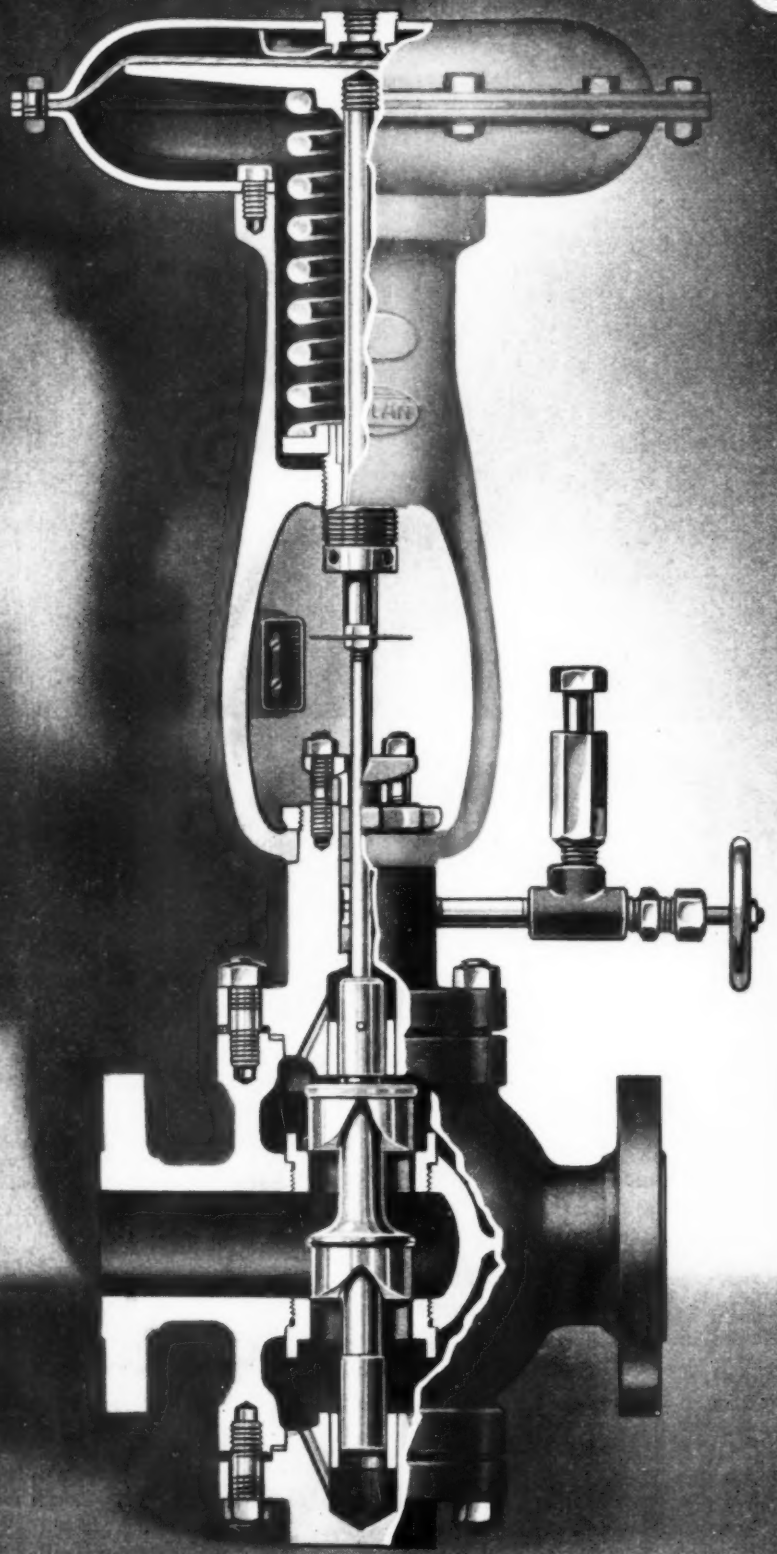
FABRICATED STEEL CONSTRUCTION

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

★ BETHLEHEM STEEL ★

BETHLEHEM OIL AND GAS PIPE

New Design



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Combines Practical Features

MASONEILAN
Air Operated
CONTROL VALVES
...Insure Better Performance

Incorporated in the new Masoneilan control valves are many practical features that provide users with better-than-ever control.

Highly Responsive

- Design insures minimum of hysteresis.
- Large effective area, moulded diaphragms provide positive response.

Compactness

- Facilitates installation.
- Adds to overall sturdiness.

Reproducibility of Parts

- Modern machinery, tools and fixtures; precision manufacturing methods; rigid inspection during processing and assembly — all insure exact reproducibility of parts — uniform performance.

Interchangeable Parts

- Comparable parts interchangeable between all Percentage Parabolic and Percentage V-Port Valves.
- Trim sizes interchangeable among Percentage Piston Valves.
- Springs for 6-30 psi range may be substituted for 3-15 psi range.

Easy to Service

- Serial plate gives full information.
- Yoke removed without disturbing bolted stuffing box.
- Indicator plate marked in ⅛ inch graduations gives true travel indication, correct rated stroke; makes accurate stem readjustment (after disassembly) automatic.
- External type adjusting screw (in sizes 2" and up) for setting spring initial.

For design details and specifications write for bulletin

MASONEILAN

REG U.S. PAT. OFF.

MASON-NEILAN REGULATOR CO.

1185 ADAMS STREET, BOSTON 24, MASS., U. S. A.

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These Valves Meet the Rigid Requirements and Specifications of the Most Exacting Users

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FLEXIBLE DESIGN

is the pay-off with ALCO AIRCOOLERS

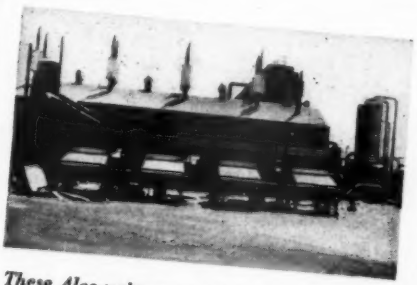
Radiator core or fintube—you can get either type from Alco. Experienced engineers study your needs and then give you dependable, impartial counsel as to the **Aircooler** that's best for *your* job. Better yet, once these units are on the job, worries about scale, water shortages, expensive water treatment and similar cooling troubles are gone.

Put Alco's flexible design and the other "big 5" features to work in your plant now. For more details send for the free Alco **Aircooler** Catalog or contact your nearest Alco Sales Engineer at Chicago, Cleveland, Houston, Kansas City, Los Angeles, New York or Tulsa. Plants at Dunkirk, N. Y. and Beaumont, Texas.

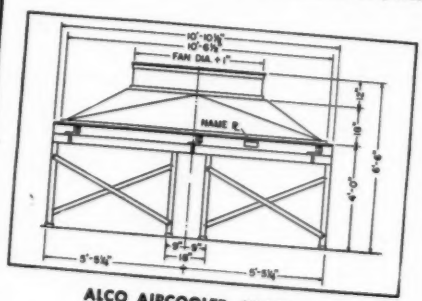
ONLY ALCO HAS THE BIG 5

1 Low Cost
2 FLEXIBLE DESIGN
3 Efficient Performance
4 Easy Maintenance
5 Quick Installation

ONE AIRCOOLER FROM THE ALCO LINE



These Alco units are cooling lube oil in large western plant. Other similar units have been used for cooling jacket-water, gas, vapors, etc.



ALCO AIRCOOLER, MODEL 81
CONDENSED SPECIFICATIONS

No. radiators—Four 8-ft. nominal length.

Fans—6 or 7 ft. dia.—2, 4 or 6 blade—adjustable or fixed pitch.

Drive — Direct Electric Motor (V-belt or Gear Drive can be furnished on request).

Surface External—3,519 sq. ft. Style T-5 (Water Core)—3,393 sq. ft. Style T-1 (Oil Core).

Surface Internal—581 sq. ft. Style T-5—440 sq. ft. Style T-1.

Face Area—59.6 sq. ft.

ALCO
ALCO Products Division
AMERICAN LOCOMOTIVE COMPANY

In step with tomorrow — ALCO AIRCOOLERS, Heat Exchangers, Evaporators, Feedwater Heaters, Pressure Vessels, Pipe

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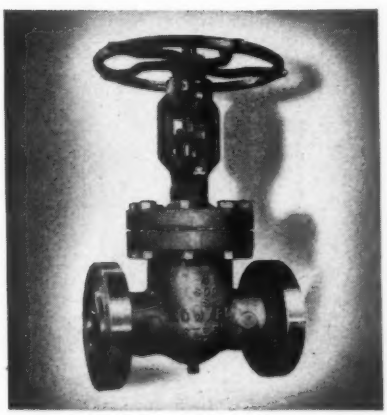
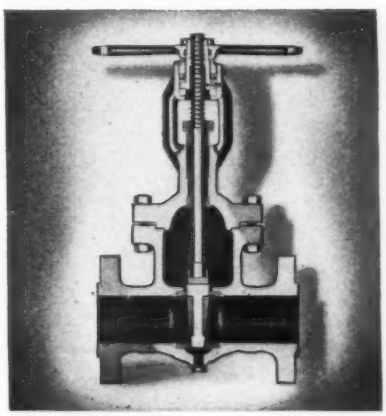
WANTED

INFORMATION AS TO THE WHEREABOUTS OF ONE EDWARD GATE VALVE WHICH ISN'T PERFORMING SATISFACTORILY!





DESCRIPTION: Close fitting wedge guides prevent wear-producing wedge drag on seating faces—accurately located with respect to seating faces and wedge, then welded integral to the body while master wedge is still in place • Looseness eliminated and wear reduced to a minimum • One-piece bonnet aligns stem accurately • Needless weight and unnecessary working parts eliminated • Two tight seating faces • Ball bearing yoke makes operation easy • Uniform metal sections reduce distortion in heating and cooling • Integral but replaceable hard surfaced seats greatly lengthen valve life.

The Edward Gate Valve Apparently Has a Perfect Record—We Have Literally No Information on Service Complaints!

Since the Edward Gate Valve was introduced, not one valve deficiency has been recorded. Our men are still on the lookout for information concerning the whereabouts of an Edward Gate Valve in need of service. If you know of, or can find, any Edward Gate Valve requiring attention, please contact your Edward Valve representative, or get in touch with our main office. Your help will be greatly appreciated.

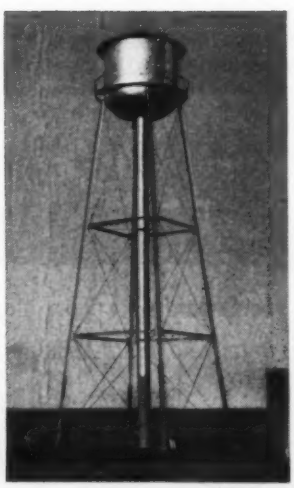
Another Product

Edward Valves, Inc.

Subsidiary of ROCKWELL MANUFACTURING COMPANY

EAST CHICAGO, INDIANA

PITTSBURGH • DES MOINES *INDUSTRIAL*



Elevated Steel Tanks

Choose the Pittsburgh-Des Moines Elevated Steel Tank meeting your precise requirements in type and capacity, and you will enjoy every benefit of safe and certain water supply—at lower cost *—with guaranteed dependability.* Write for our latest "Modern Water Storage" Brochure.

PITTSBURGH • DES MOINES STEEL COMPANY

Plants at PITTSBURGH, DES MOINES and SANTA CLARA

Sales Offices at:

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Bingham

PRECISION BUILT FIELD PROVEN PUMPS

"Double Volute" HIGH PRESSURE Pumps

Bingham Multi-Stage Pumps are of "Double Volute" design, insuring perfect radial balance — unusually short spans between bearings — case bolts uniformly located close to shaft centerline — integral crossovers producing casings of maximum strength for high pressure service.

Bingham "Double Volute" Multi-Stage Pumps have been field proven for such high pressure service as Pipe Line Booster Stations, Cold Charge Pumps, Boiler Feeders, Lean Oil Circulation, and other applications requiring the utmost in sustained efficiency and low maintenance.

• • •

It takes Big Precision Tools like these to Build Pumps like this

Bingham Multi-Stage Pumps, like all Bingham products, are precision built in our new and modern plant. All rotating parts are dynamically balanced. All parts requiring close tolerances are ground on heavy duty precision grinders. Each part is subjected to rigid inspection by craftsmen who for years have been trained to follow Bingham's high standards of manufacture.

A typical booster station equipped with Bingham "Double Volute" multi-stage pumps on Magnolia Pipe Line Company's 20-inch line.

One of the heavy duty horizontal boring mills in our new and modern plant.

SEND NOW for book describing the principle and advantages of Bingham "Double Volute" pumps.

Bingham — DOUBLE VOLUTE RADIAL BALANCE — PUMPS SINCE 1921

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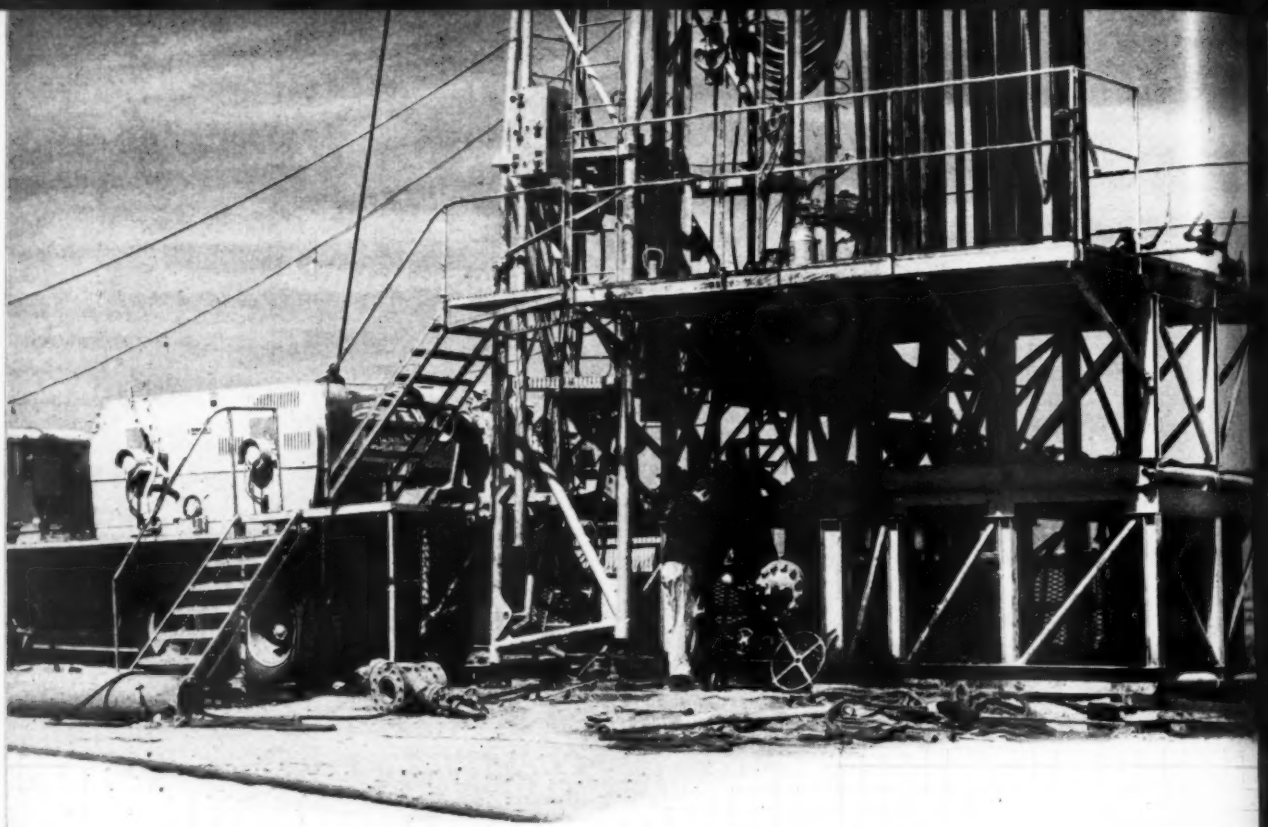


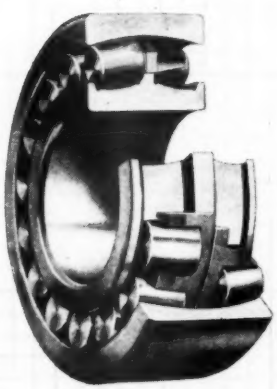
telescoping time and cost...

WITH TORRINGTON SPHERICAL ROLLER BEARINGS

Franks Manufacturing Corporation portable rigs are designed to telescope time and cost in set-up and operation. This is accomplished with a telescoping mast and Torrington Spherical Roller Bearings in rotary table, draw works and other related equipment.

Spherical Roller Bearings are automatically self-aligning. They operate freely under deflection, and require no periodic alignment adjustments. Power requirements are less. Long service is secured with minimum maintenance.

Reduce the maintenance and operating costs of your product by specifying Torrington Spherical Roller Bearings. Our engineers will be glad to lend you a hand with design and application problems.



THE TORRINGTON COMPANY

South Bend 21, Ind. • Torrington, Conn.

District Offices and Distributors in Principal Cities of United States and Canada

TORRINGTON *SPHERICAL ROLLER* **BEARINGS**

SPHERICAL ROLLER • TAPERED ROLLER • STRAIGHT ROLLER • NEEDLE • BALL • NEEDLE ROLLERS

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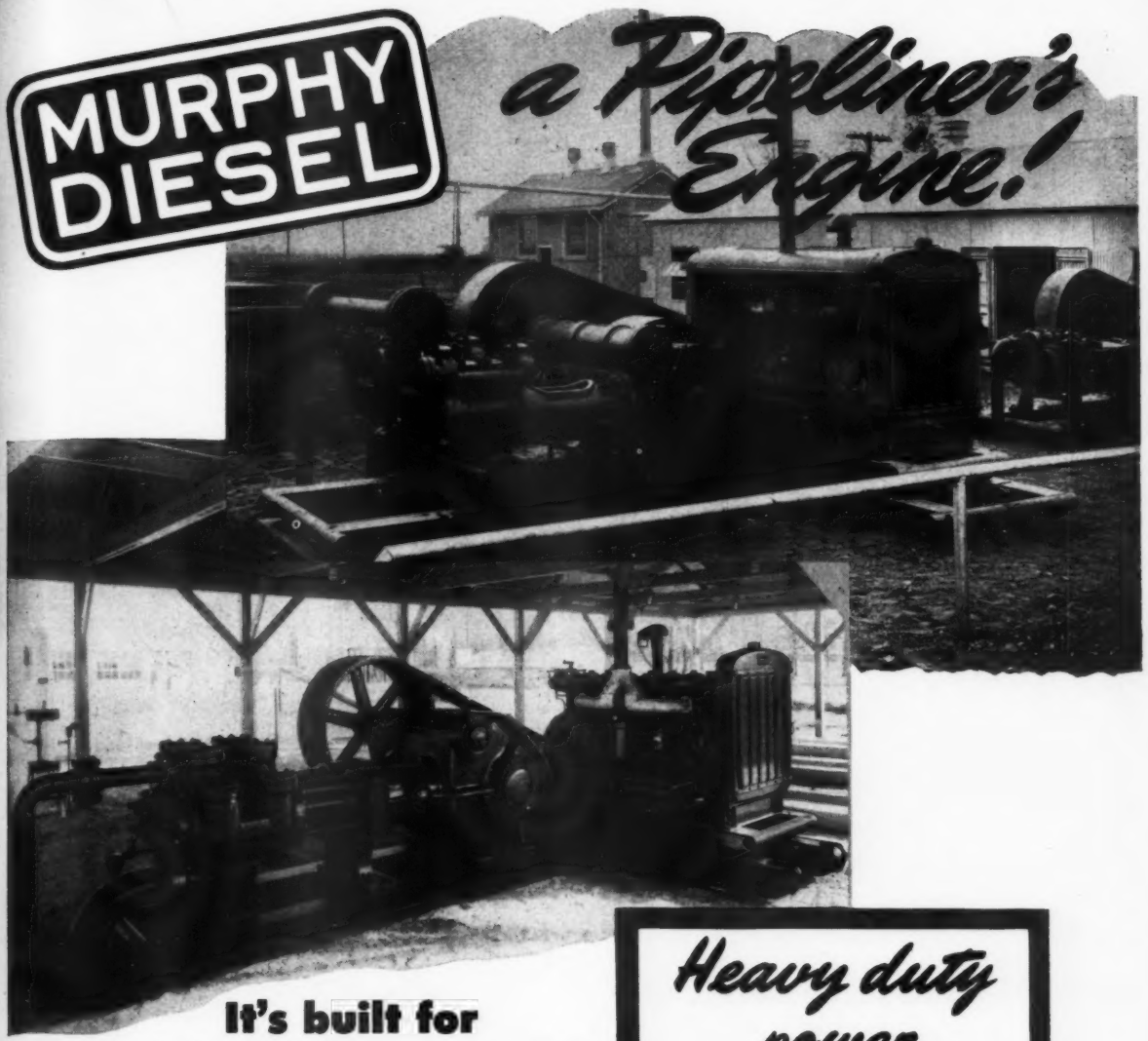
MURPHY DIESEL

a Pipeliner's Engine!



It's built for 'round-the-clock operation

Economy and dependability — that's the combination that makes Murphy Diesel the answer to a pipeliner's needs. With unit fuel injection and "true" diesel operation — solid fuel injected directly into a plain, open combustion chamber — the Murphy Diesel uses less fuel per horsepower hour than *any* other diesel of comparable power rating. Dependability is assured by quality workmanship and an exclusive combination of design features such as... four valves per cylinder... extra large crankshafts and bearing surfaces... hydraulic servo-type governor... through steel tie bolts... oil cooled pistons... dual overhead camshafts ...and many others.

Heavy duty power

for the oilfields

Murphy Diesel Engines and Power Units in 24 models for pipeline pumping and drilling, 90 to 220 H.P., 1200 and 1400 R.P.M. Diesel-Electric generating Sets 60 to 133 K.W. Diesel and Dual-Fuel; also Crude Oil.

Before you buy your next diesel for pipeline pumping service be sure and look into the advantages of Murphy Diesel Power. Ask your Murphy Diesel Dealer for full details or write direct.

MURPHY DIESEL COMPANY

5305 W. Burnham St., Milwaukee 14, Wis.

FACTORY BRANCH — Sales, Parts and Service: 113-117 South Elwood Street, Tulsa, Oklahoma

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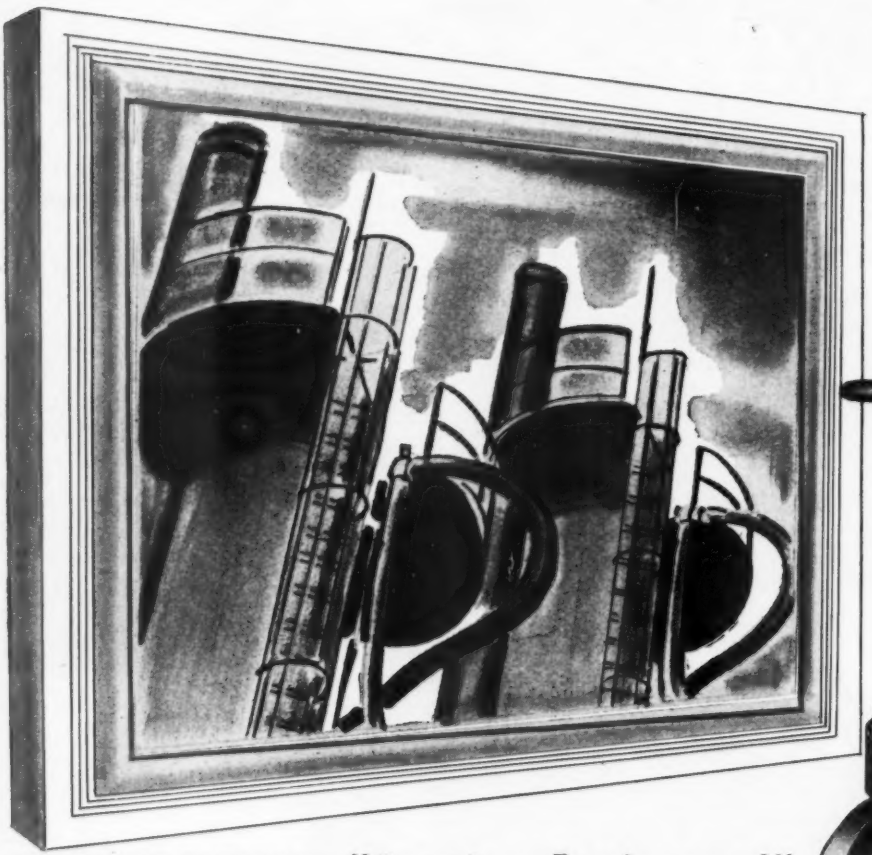
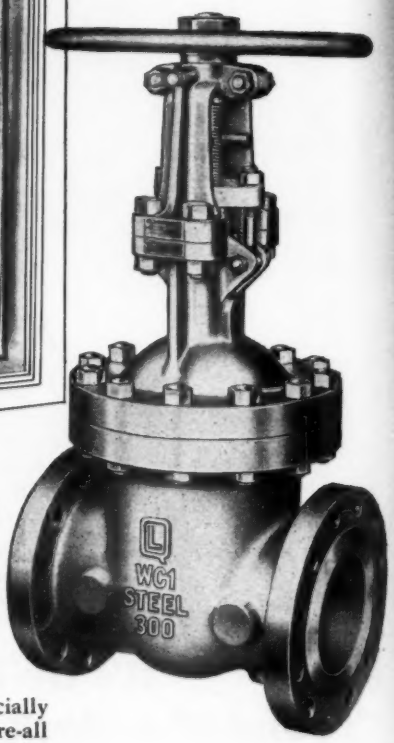




LUNKENHEIMER "Service-Engineered" Steel Valves Will Meet YOUR SPECIFIC APPLICATION PROBLEMS

MAINTENANCE costs need specialized attention, these days—especially in your field, where steel valves are important. There's no cure-all for your valve maintenance problem. It has to be tackled an installation at a time — service by service — and that's where Lunkenheimer engineering comes in.

Maintenance costs are bound to be high wherever your steel valves aren't *perfectly* suited to the service. To cut those costs, get a *perfect match*. Check the *important* things—trim combinations to insure against galled parts . . . the kind of alloys used for oil service and the different kinds for steam and non-lubricating fluids . . . stem connections . . . gaskets . . . bolts. Lunkenheimer steel valves are designed with a service in mind, and we will supply the correct valve for your *specific* needs.

Call in the Lunkenheimer representative in your area. He'll be glad to put at your command all the generations of successful experience behind Lunkenheimer's complete selection of "service-engineered" steel valves. For his address, write The Lunkenheimer Co., P. O. Box 360F, Cincinnati 14, Ohio.

STEEL • • • IRON • • • BRONZE

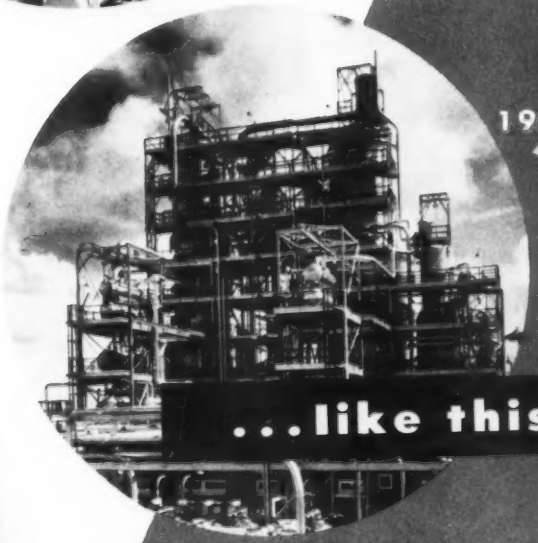
LUNKENHEIMER

THE ONE *Great* NAME IN VALVES

L-850-13A

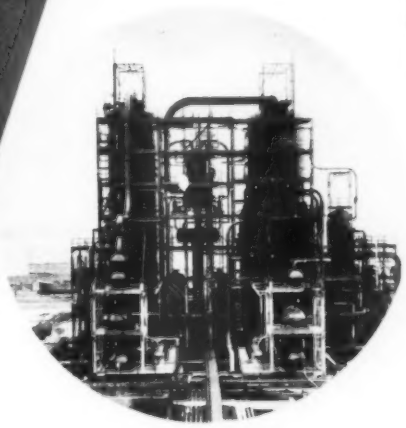
1951
48,000 bbl/day

another one...



1949
48,000 bbl/day

...like this



1940
3,000 bbl/day

A sound design lives on...

...and is reproduced many times

The design of the 1940 unit was "right",—it was duplicated, essentially, in the 1949 unit,—it will be reproduced again in the 1951 unit.

These three crude distillation units are products of the complete engineering and construction service that is Foster Wheeler and were designed and constructed for a major Gulf Coast refiner in collaboration with the engineering department of that company.

FOSTER WHEELER CORPORATION

165 BROADWAY, NEW YORK 6, NEW YORK

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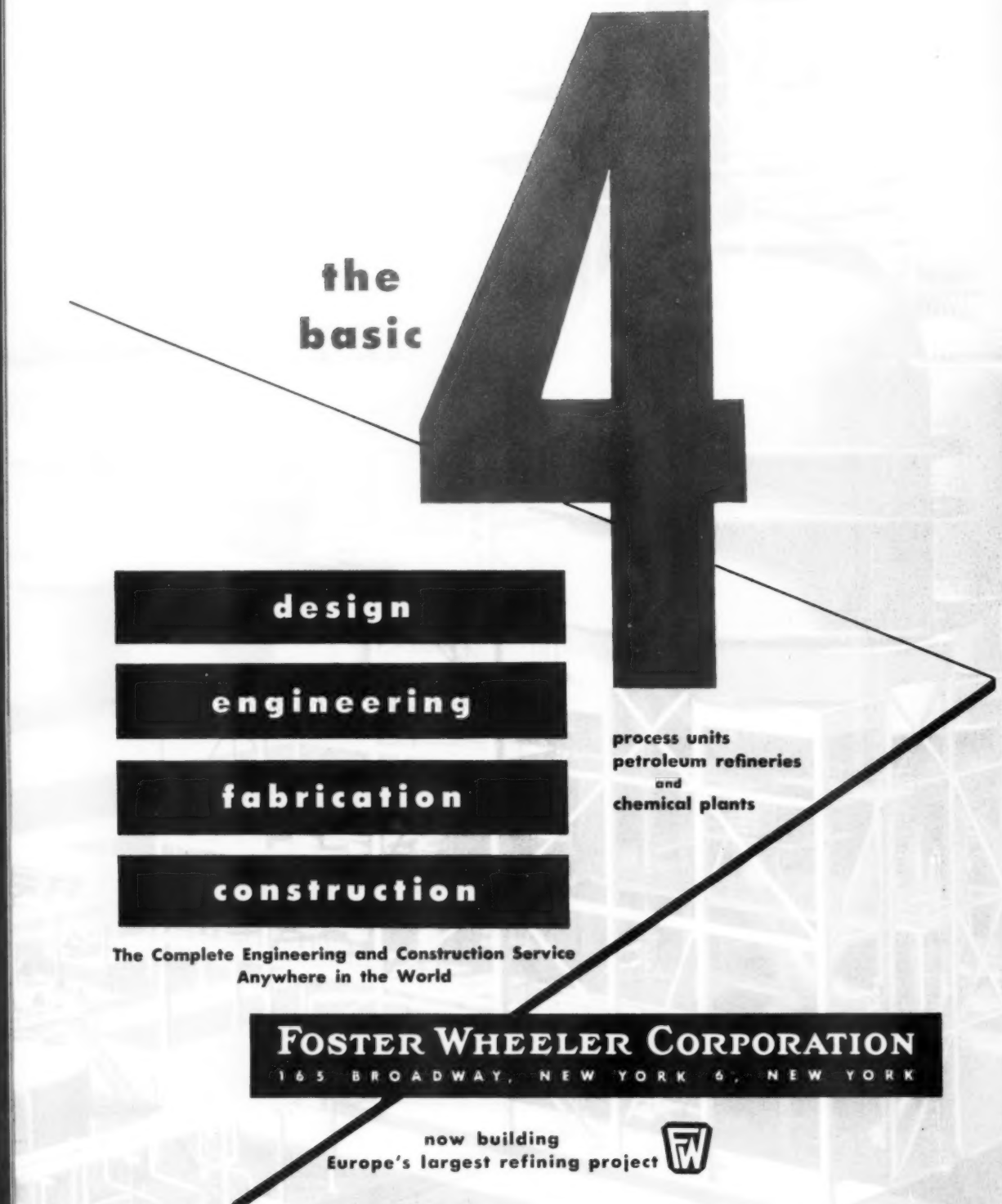
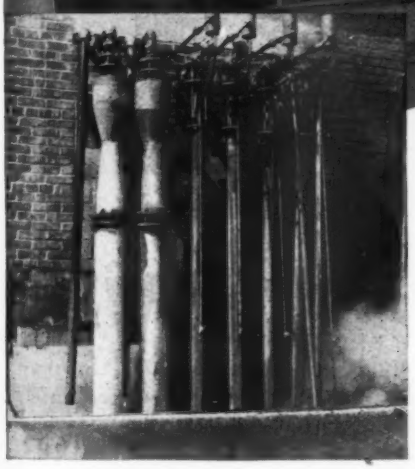

the
basic
4
design
engineering
fabrication
construction
process units
petroleum refineries
and
chemical plants
The Complete Engineering and Construction Service
Anywhere in the World
FOSTER WHEELER CORPORATION
165 BROADWAY, NEW YORK 6, NEW YORK
now building
Europe's largest refining project
FW

THIS *ScrubTeam* BEAT THE FUME AND DUST MENACE



The four 48" SK Fume Scrubbers in the top view are used for absorption of sulphurous fumes in an oil refinery.

The two 6" SK Fume Scrubbers in the lower photo are made of Haveg and handle hydrochloric acid vapors at the plant of a large producer of synthetic materials.

OBNOXIOUS, contaminating fumes and vapors—heavy, corrosive and dangerous dusts—*need not* create a major plant problem, *can* be effectively and economically controlled.

To meet and master varying conditions in the battle against this menace, SK manufactures a wide range of types and sizes of Vapor Condensers or Fume Scrubbers—a team specially designed for such service.

If your conditions are such that fumes or dust can be knocked down and scrubbed with water or other liquid, an SK Fume Scrubber can do the job economically. Simple in construction, these units produce their own draft and give complete mixing without possibility of by-pass.

Standard and Special Fume Scrubbers are available in various materials such as cast iron, welded steel plate, Haveg, stoneware, hard lead and other corrosion resistant alloys or chemical resistant linings. Rubber lining is available with cast iron or welded steel plate.

For complete information, write for Bulletin 4-R. If your problem is immediate, call or teletype.

SCHUTTE and KOERTING Company

Manufacturing Engineers

1175 THOMPSON ST. • PHILADELPHIA 22, PA. • TWX No.: PH 782

JET APPARATUS • HEAT TRANSFER EQUIPMENT • STRAINERS • CONDENSERS AND VACUUM PUMPS • OIL BURNING EQUIPMENT • ROTAMETERS • FLOW INDICATORS • RADIAFIN TUBES • VALVES • SPRAY NOZZLES AND ATOMIZERS • GEAR PUMPS • DESUPERHEATERS

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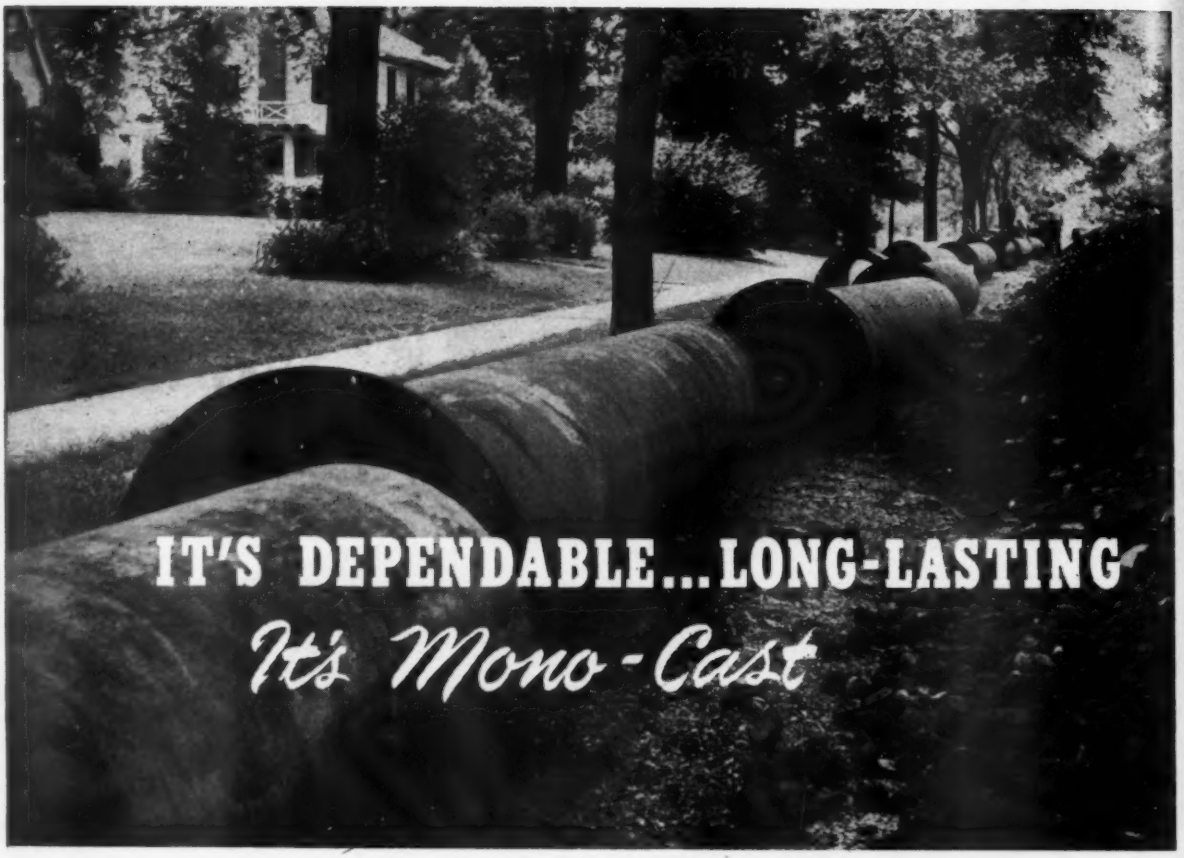

MONO-CAST Pipe For Every Service Condition

"Mono-Cast" is the trade name for Acipco pipe cast centrifugally in sand-lined molds. Uniform metal section, high physical strength, endurance, and freedom from inclusions are salient properties which have established the name "Mono-Cast" as synonymous with "highest quality cast iron pipe". It can be supplied with joints for conveying water, gas, oil, gasoline, sewage, salt brine, ashes—and in fact, just about everything that a pipe line can conceivably convey.

Being cast iron, Mono-Cast Pipe enjoys an enviable reputation. Cast iron pipe has had over three hundred years of service abroad and more than one hundred years of service in the United States. It is satisfactorily serving in locations where especially severe external and internal corrosion conditions exist, Mono-Cast Pipe is designed to give super-service; and its wide acceptance and splendid performance bespeak its excellence and the confidence and esteem in which it is held by those who are using it.

Since the beginning of our Company, forty-five years ago, Acipco has constantly worked hand in hand with engineers, contractors and superintendents in solving piping problems in their respective fields. Refer your next piping job to Acipco, and utilize the extensive manufacturing facilities of the largest individual cast iron pipe foundry in America.

AMERICAN CAST IRON PIPE COMPANY

Birmingham 2, Alabama

Dallas Houston El Paso Pittsburgh Kansas City New York City
Chicago Minneapolis Cleveland Los Angeles San Francisco Seattle

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THE RIGHT CHAIN FOR EVERY INSTALLATION
BUILT-IN STAMINA FOR LONGER WEAR

Single or multiples . . . regular or heavy duty . . . standard or extended pitch . . . steel, stainless steel or bronze, Atlas makes them all with exclusive Atlas Built-In Stamina.

The Atlas Nicarb Process used for case hardening bushings and pins assures built-in stamina and super life to every length of chain. Nicarbing provides a tough outer surface bound to a core of steel which assures greater strength and wear resistance.

Each link plate and roller is made of wear-resistant, heat-treated alloy steel with precision uniformity scientifically achieved with the most modern electronically controlled furnaces.

Whatever your requirements in roller chain, look to Atlas for longer life and better service. Atlas Engineers are ready to supply you with the exact type of chain for the drive that will provide greater efficiency . . . improved economy . . . and less maintenance. For the full story on how Atlas "Super-Life" Roller Chain can help you on every drive, write to ATLAS CHAIN and MANUFACTURING COMPANY, Philadelphia 24, Penna.

"SUPER-LIFE"

ATLAS CHAIN

for More Ease of Service

There's More Worth in KENWORTH

Costs go down when maintenance is made easy. To take the sting out of those famous last words—"it's not the cost but the upkeep"—Kenworth builds for the greatest ease of service. All components are easily accessible—air cleaners are outside mounted; Kenworth's "inside-out dash" brings the instrument panel within easy reach and view; batteries are mounted on the running board; lubrication points are readily available; the radiator shell and grill are removable as a unit. This careful attention to these and other details adds up to economical maintenance for you.

Petroleum Transportation, Inc., of Seattle, operating two million miles a year over the highways of Washington, Oregon, Idaho and Montana, has a 22-year record of pioneering and progress in the transportation of petroleum products. A long-time and consistent Kenworth customer, Lamar Strain, vice-president of this successful firm, says: *"Our experience in operating a large fleet of Kenworth trucks under all types of weather and road conditions has impressed us with the economies which are gained when trucks are engineered for ease of service."*

KENWORTH

TRUCKS ★ BUSES

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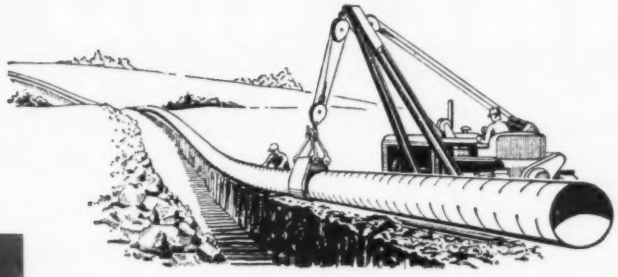


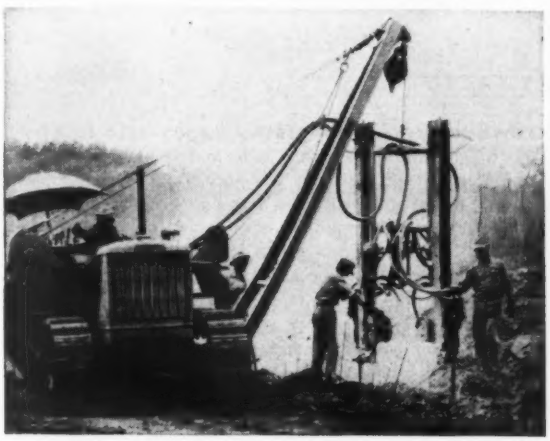
Q. How can I always keep the trench ahead of my pipe laying crews?

A. Use the Gardner-Denver Twindril—the modern rock drilling unit that keeps your rock trenching operations far ahead of your fast-moving pipe laying equipment.

DRILLS TWIN HOLES IN 3 MINUTES. In middle western limestone, the Gardner-Denver Twindril drills two holes in only 3 to 4 minutes' time. That includes both drilling time and moving up for the next pair of holes. A corresponding speed-up is made in harder rock formations.

DRILLS HOLES TO ANY REQUIRED DEPTH. The Twindril drills a pair of holes—one on each side of the trench—to any required depth. It's adjustable for use in any trench from 2½ to 5 feet wide.

A.



A SELF-CONTAINED, PACKAGED UNIT. The Gardner-Denver Twindril—completely assembled at the factory—comes ready to hang from the side boom of your tractor. It consists of two heavy-duty, 4-inch drills—with easily controlled air motor driven feeds—clamped to a welded frame of extra heavy pipe. Air for the drills is furnished by a Gardner-Denver WBK-500 Caterpillar Diesel Powered Portable Air Compressor, hooked behind the tractor. *Write for complete details.*

SINCE 1859

GARDNER-DENVER

Gardner-Denver Company, Quincy, Illinois
In Canada: Gardner-Denver Company (Canada) Ltd., Toronto, Ontario

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WHELAND BLOCKS

WHELAND CROWN AND TRAVELING BLOCKS HAVE:

BEARINGS that are really engineered for the job—exclusive double row sealed AMERICAN roller bearings having integral thrust shoulders, assuring perfect sheave alignment. SHEAVES are statically balanced, smooth running, large diameter—rope grooves are flame hardened for longer sheave and rope life. Grooved to A.P.I. Standards and can be welded and re-cut. Sheaves and bearings are INTERCHANGEABLE between mating Wheland Crown and Traveling Blocks. LUBRICATION is by conveniently located pressure grease fittings direct to inner race of each individual bearing.

The Best Buy in Blocks

4 TO 1
SAFETY FACTOR

K-3500

WHELAND CROWN BLOCKS, J-2500—250 Ton, J-3500—350 Ton—Fully streamlined heavy duty—light, compact, strong. Can be taken up in one piece on a single line over end spacer castings. Compact, will pass A. P. I. water table opening. Easy to anchor securely by hook bolts. Easy to line up with hole and keep lined up. Easy to reeve. Optional arrangements for cat line and sand line sheaves. Meets A. P. I. Specifications. Full mechanical details sent free on request.

WHELAND TRAVELING BLOCKS, K-600—60 Ton, K-1350—135 Ton, K-2500—250 Ton, K-3500—350 Ton—Fully streamlined heavy duty, fast falling—and unusually stable because of low center of gravity and smooth running large diameter sheaves. They are easy to handle, easy to reeve. The three piece guards are arranged for reeving cable without removal. However, each side guard may be readily swung out or removed for inspection or reeving. Heavy steel plate guards fully protect cable and prevent jumping from sheave grooves. Quick and full opening bottom bail—alloy steel forging.

These blocks meet the new A. P. I. Tentative Standards. A study of the many superior design and construction features will quickly show you why we say: "The Best Buy in Blocks."

Write for Bulletins giving mechanical details. Free on request.

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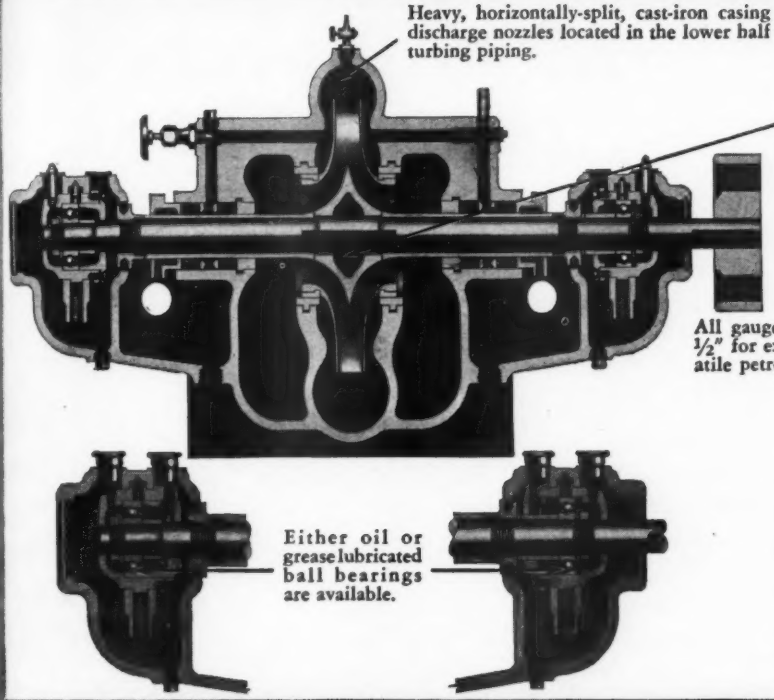
SWIVELS • ROTARIES • SLUSH PUMPS • CROWN BLOCKS • TRAVELING BLOCKS • DRAW WORKS

Designed for Low Maintenance


Heavy, horizontally-split, cast-iron casing construction with suction and discharge nozzles located in the lower half for easy inspection without disturbing piping.
Corrosion resistant impellers of double suction, enclosed type. Carefully balanced. Water passages are hand finished to a smooth surface.
Flanges are standardized at 250 lb thickness, with 125 lb drilling, to meet petroleum industry requirements for extra strength.
All gauge connections standardized at ½" for extra strength in handling volatile petroleum liquids.
Either oil or grease lubricated ball bearings are available.
Minimum of ¾" drain size, except on smaller sizes, meets petroleum industry standards.

THE DEMAND FOR LOW MAINTENANCE pumps for the petroleum industry has steadily increased. To serve this specific need, Allis-Chalmers offers a *complete* line of Type S, single stage, double suction pumps, individually engineered to meet your specifications.

All parts are precision machined and carefully assembled. Heavy construction plus proper alignment of pump parts assure long life of wearing rings, sleeves, packing and bearings. Impeller and shaft are carefully balanced. Impeller clearances are accurately measured to cut recirculation losses.

Although the most common drives for centrifugal pumps are Allis-Chalmers squirrel cage induction motors, Allis-Chalmers also supplies a complete line of induction, synchronous and direct current motors, and gasoline engines of the generally used sizes for most pumping applications.

For complete information on Allis-Chalmers pumps and drives, contact your nearby A-C Sales Office, or write direct for Bulletin 08B6146A.

A-3157

ALLIS-CHALMERS, 1059A SO. 70 ST.
MILWAUKEE, WIS.

ALLIS-CHALMERS

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Power, Electrical, Processing Equipment for Petroleum Industry

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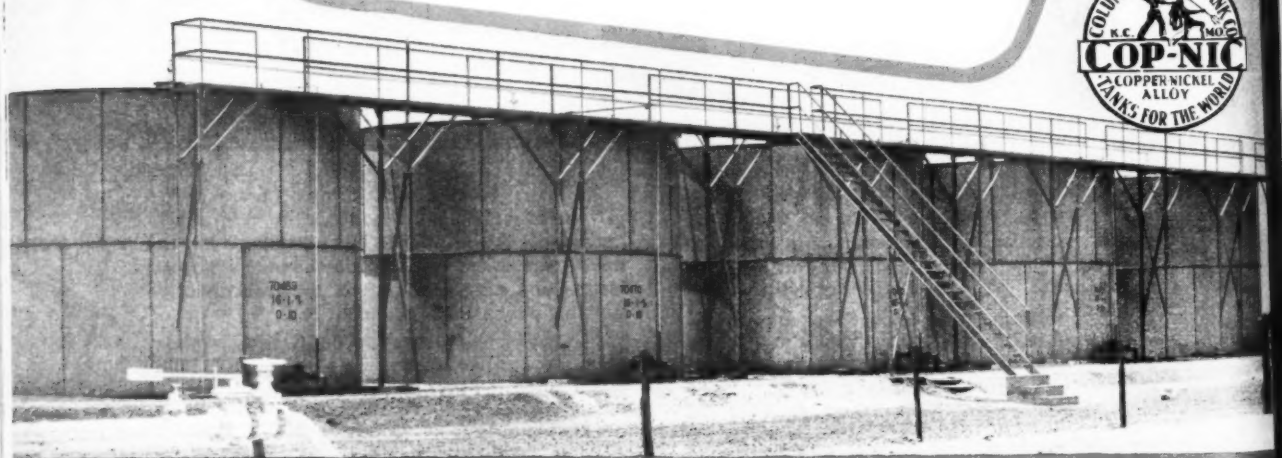
BOLTED STEEL TANKS

"Buy Word" of Oil Producers Everywhere!

Year in and year out the name "COLUMBIAN" continues to be the "buy word" with oil producers in every part of the world. Whether the requirement is for single small units for special storage or a battery of large capacity tanks, COLUMBIAN BOLTED STEEL TANKS never fail to meet the need in a money-saving way. That's because of Columbian's 57 years of experience in precision engineering and fabricating tanks that assure long years of trouble free service. You'll also appreciate the many exclusive construction features that make Columbian Tanks easily assembled by unskilled labor. Make "COLUMBIAN" your "buy word" in tanks and you buy the best.

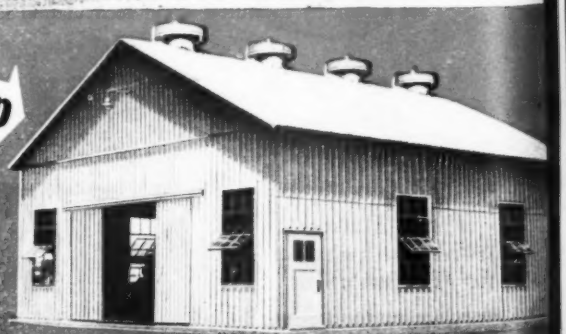
COLUMBIAN STEEL TANK CO. TANKS FOR THE W... KANSAS CITY, MO.

COLUMBIAN STEEL TANK CO. K.C. MO. COP-NIC COPPER NICKEL ALLOY TANKS FOR THE WORLD



Rigid • Strong • Fire-Safe • Low Upkeep

COLUMBIAN ALL-METAL BUILDINGS are "naturals" for long-lasting, protective storage of equipment of all kinds. Easily assembled—easily knocked down and re-assembled without damage. Ideal for warehouses, engines, houses, garages. Minimum upkeep cost for years on end.



COLUMBIAN STEEL TANK CO., P. O. Box 4226-H, Kansas City, Mo.

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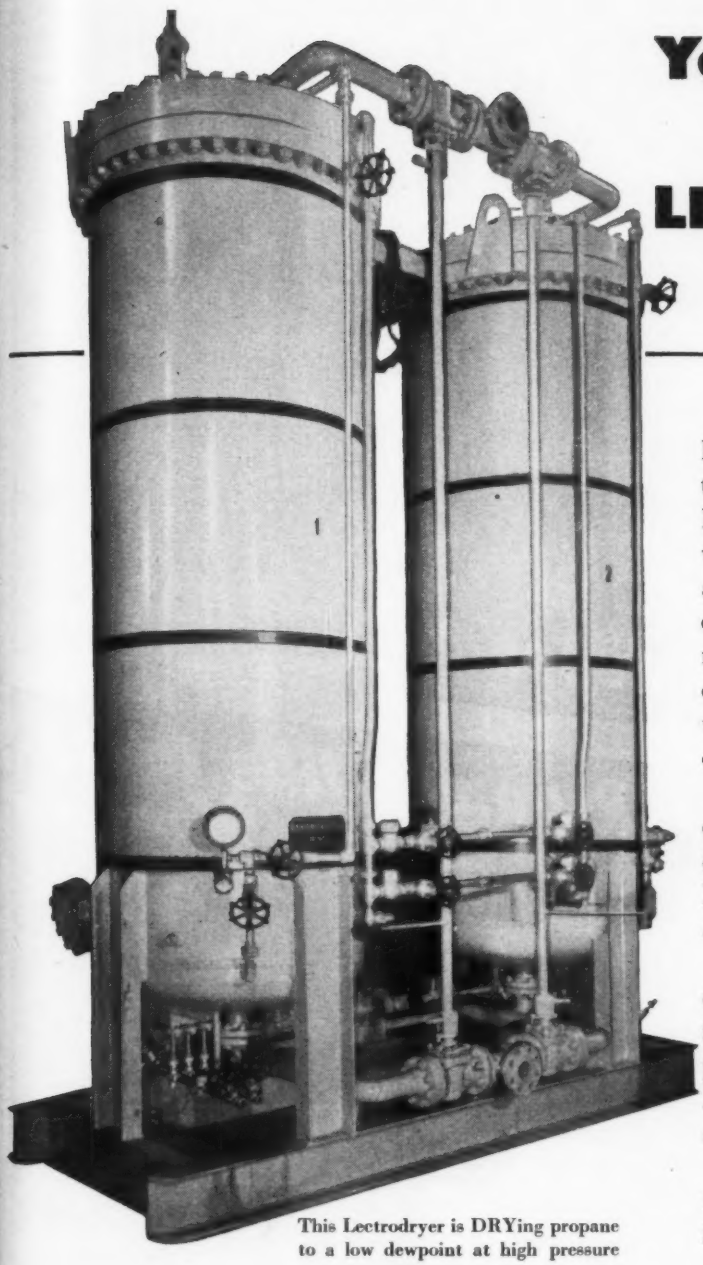

This Lectrodryer is DRYing propane to a low dewpoint at high pressure

You pay so little for LECTRODRYER'S experience

Lectrodryer engineers are veterans at this DRYing business. They started DRYing air, gases and organic liquids when a processor had to design, build and gamble on the effectiveness of his own drier. Today the knowledge our men have gained throughout the years, on jobs in every industry all over the world, is at your command without extra cost.

No need for you to have the bother, extra expense and delay which so often develop in building a new product. Lectrodryers are as standard as motors; a type and size for every service.

Let Lectrodryer advise you on a drier when the job is still on the drawing board. You may save at several points by using standard equipment. And, when the Lectrodryer gets on stream, you know it's going to work.

For DRYing help, write Pittsburgh Lectrodryer Corporation, 325 32nd Street, Pittsburgh 30, Pennsylvania.

In England: Birlec, Limited, Tyburn Road, Erdington, Birmingham.
In Australia: Birlec, Limited, 51 Parramatta Road, Glebe, Sydney.

LECTRODRYERS DRY WITH ACTIVATED ALUMINAS

LECTRODRYER

REGISTERED TRADEMARK U.S. PAT. OFF.

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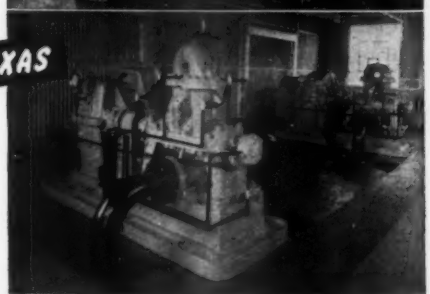
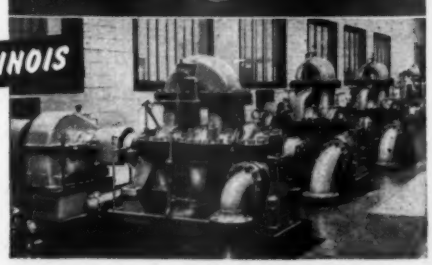
Many pipelines depend on I-R pumps like these





Moving liquids through the world's vast network of pipelines requires the service of *thoroughly reliable and efficient pumps* . . . proven pumps that will perform their task continuously, 24 hours a day.

That's why Ingersoll-Rand "RT" pumps are used so extensively for pipeline service. These are heavy-duty units having the stamina to stay on the job with a minimum of attention. Carefully designed impellers and large, smooth liquid passages assure high sustained hydraulic efficiency and low power costs.

As an added feature, "RT" pumps can be equipped with the Cameron Shaft-Seal which replaces conventional stuffing-box packing and practically eliminates stuffing-box maintenance.

An Ingersoll-Rand engineer will be glad to help you with your pumping problems. Be sure and ask him for a copy of Catalog 7148 describing "RT" pumps.

Ingersoll-Rand

CAMERON PUMP DIVISION 449-10

11 BROADWAY, NEW YORK 4, N. Y.

Since 1860 . . . Pioneering in the development of better pumps.

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BIGNESS

COMES IN HANDY!

In Peace—In War!

PEARL HARBOR surprised and shocked America. What happened after that surprised and *flattened* the Axis!

American industry demonstrated the amazing ability of its big companies to expand swiftly and efficiently to meet any need!

In Petroleum, companies like Socony-Vacuum with armies of technicians and workers, vast modern equipment, converted almost overnight to war production.

For example, by March, 1945, the wartime peak, the petroleum industry had increased annual output of aviation fuels (all grades) by more than 40 times over 1940! And during the same period, Socony-Vacuum *multiplied, by over 70 times*, its output of special high octane aviation gasoline, one of U. S. A.'s most potent weapons of World War II . . . with volume zooming from less than 300,000 barrels a year to a staggering rate of 20,000,000 barrels!

Today, by public demand, America is producing petroleum products at the yearly rate of over 2,080,000,000 barrels—and Socony-Vacuum is proud of the bigness that enables it to do its part.

The Flying Red Horse Companies

SOCONY-VACUUM OIL COMPANY, INC., and Affiliates:

MAGNOLIA PETROLEUM COMPANY • GENERAL PETROLEUM CORPORATION

SOCONY-VACUUM

BIGNESS SERVES AMERICA—PROTECTS AMERICA!

On or off the road

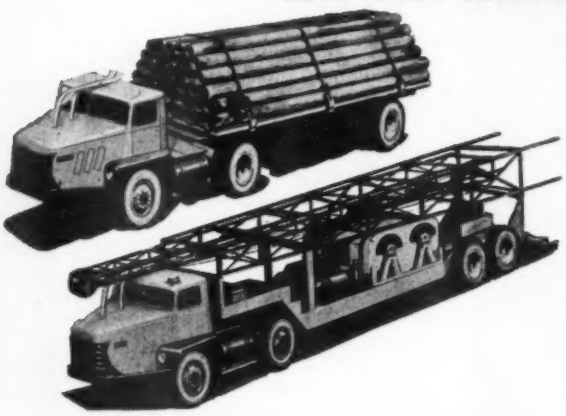
— you get there *fast* and *unfailingly* with

WALTER TRACTOR TRUCKS

— the only trucks with 100% TRACTION

Walter Tractor Trucks pull steadily through conditions that stop other trucks—sand, mud, soft dirt, snow, steep grades. Every horsepower is converted into tremendous haulpower by the exclusive Walter Four Point Positive Drive, which provides 100% traction in four driving wheels. No wheel slipping or spinning, no stalling of loads.

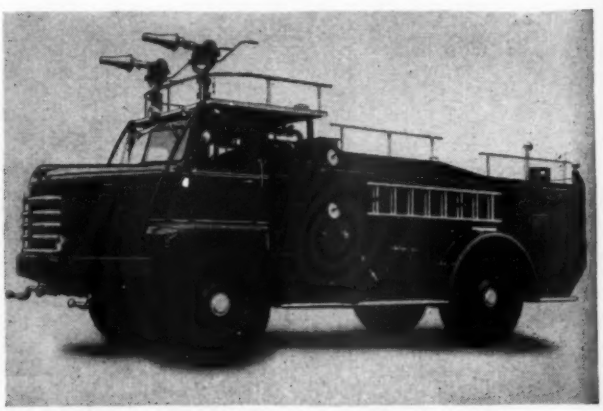
LOW COST HAULING of Rigs, Pipe and Heavy Equipment



With big, powerful, rugged Walter Tractor Trucks, you haul bigger loads—require fewer trucks and trips—avoid delays and stalled loads in bad running conditions. This all-weather hauling ability, plus faster running time, cuts down unproductive time for equipment and crews. Proper weight distribution permits hauling within 18,000 lbs. per axle loading limits on the highway. Gasoline, diesel or butane engines, 240, 260 and 300 hp. Hydraulic power steering and air brakes provide easy, safe handling.

NEW! High-speed, high capacity *WALTER FIRE FIGHTER*

This giant 42,000 lb. Walter Fire Fighter gets to any fire fast, no matter how severe the weather or running conditions. Quickly smothers oil or gasoline fires in a tremendous blanket of fire-sealing Fog-Foam. Discharges a total of 4,800 gal. of fog-foam per minute. Completely self-contained, ready for instant action. Accelerates to 45 mph. in one minute.



WALTER 4-POINT POSITIVE DRIVE
TRACTOR TRUCKS

Write for full information on these units.

WALTER MOTOR TRUCK CO.

1001-19 Irving Ave., Ridgewood 27, Queens, L. I., N.Y.

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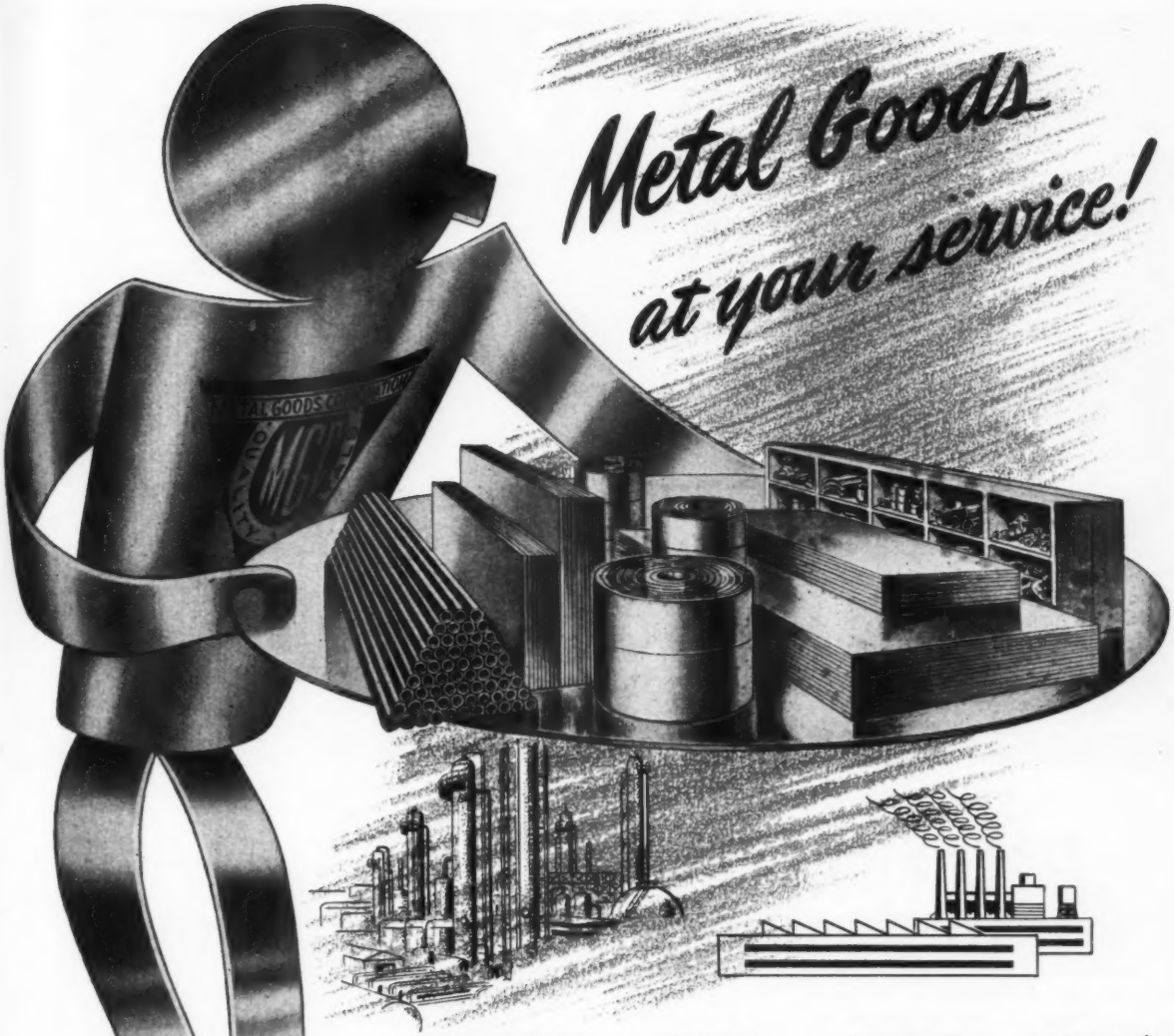

ALUMINUM . . . BRASS . . . COPPER . . . MONEL*
NICKEL* . . . STEEL . . . STAINLESS STEEL
Sheets • Tubes • Plates • Bars • Fittings • Fastenings

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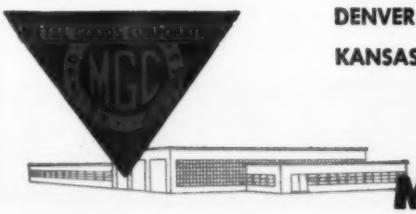
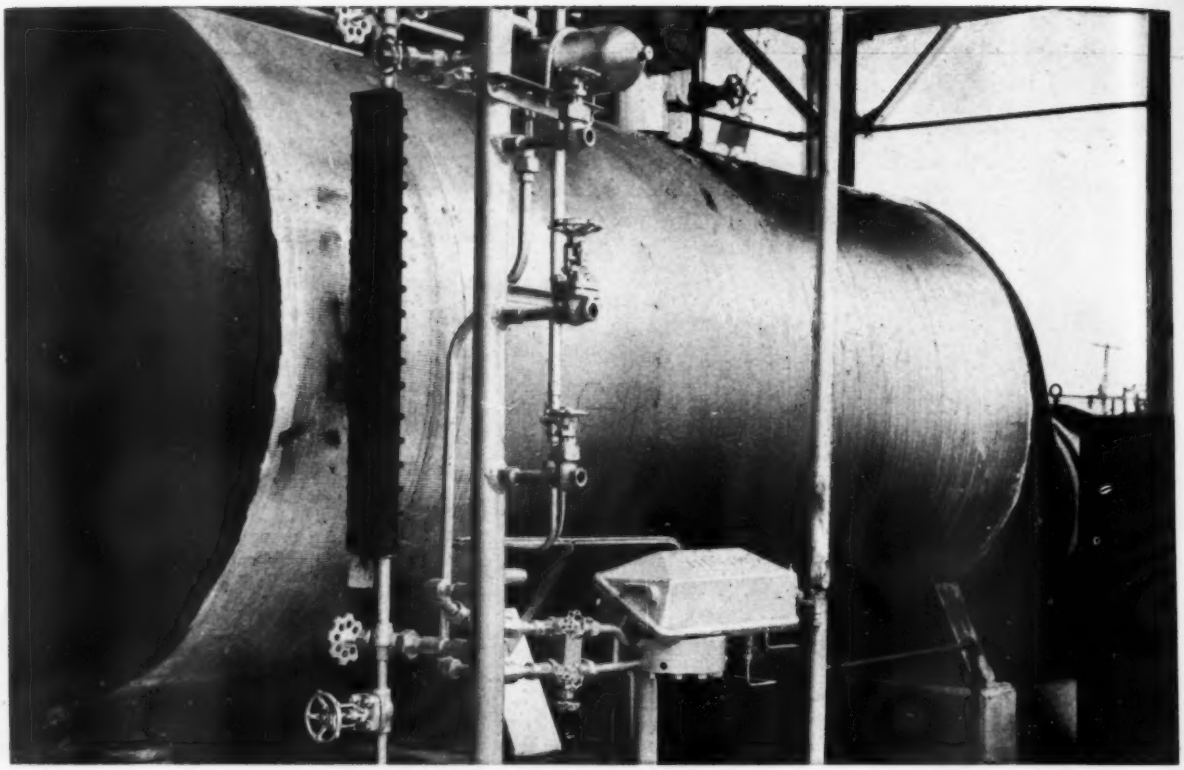
DENVER 2, COLORADO	817 Seventeenth	AComa 5891
KANSAS CITY 16, MISSOURI	1300 Burlington	NOrclay 3516

*Not warehoused in Kansas City or St. Louis.



METAL GOODS CORPORATION



Republic Transmitter measuring level in reboiler

DIFFERENT . . . in design and performance

The Republic Pneumatic Transmitter is a device for converting process variables, such as flow, level, pressure or liquid density, into air pressures. These air pressures are a direct measure of the process variables or can be used as the measuring impulse for the actuation of an automatic controller.

The force-balance method of measurement, as employed by the Republic Pneumatic Transmitter, offers many inherent advantages such as:

AMBIENT TEMPERATURE — The effect of ambient temperature variations on the accuracy of a Republic Transmitter is negligible. Since all parts are equally affected by temperature changes, force and leverage relationships are not disturbed and accuracy is unimpaired.

AIR SUPPLY PRESSURE — The effects of changes in air supply pressure is so small that it is guaranteed negligible.

LINE PRESSURE — The effect of variations in line pressure has been completely eliminated.

SENSITIVITY — Due to the negligible motions required for complete operation of all parts for full scale changes, no appreciable hysteresis results from reversal of direction of measurement change. The hysteresis loop is so small that it is undetectable by ordinary means, being less than 1/20 of 1%.

ACCURACY — The accuracy of the Republic force-balance method of measurement is higher than can be consistently secured and maintained with any other method. Transmitting pressure vs. measured force is guaranteed within ½ of 1% of meter range.

In addition to these five important features, the Republic Pneumatic Transmitter is extremely flexible in application, easy to service and of rugged construction.

If you have a flow, level, pressure or liquid density metering or contr. problem may we suggest that you investigate the Republic Pneumatic Transmitter? Data Book No. 1002, which contains complete details of this instrument, will be mailed to you upon request. Write for it today!

REPUBLIC FLOW METERS CO.

2240 Diversey Parkway, Chicago 47, Illinois

XUM

DEMPSTER DUMPSTER SYSTEM

SERVING COST-MINDED MANAGEMENT FROM COAST TO COAST

. . . handling bulk materials of every description at phenomenal savings

Photos show the three simple stages of servicing a container. The Dempster-Dumpster, operated from hydraulic controls by driver in the cab, picks up each container and hauls it to point of disposition where it may be dumped or set down intact.

ALCOA

-recognized across the nation

. . . Aluminum Company of America, well known for sound management, uses the Dempster-Dumpster System

Aluminum Company of America is among the hundreds of cost minded manufacturers, both large and small, using the Dempster-Dumpster System of bulk materials handling . . . the system recognized across the nation for its efficiency and ability to reduce costs.

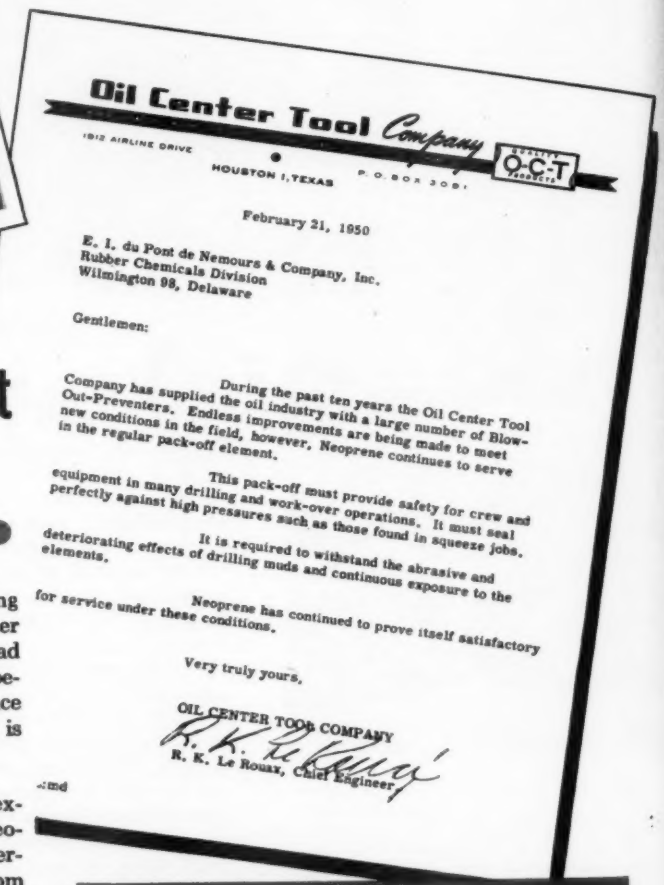
In the Dempster-Dumpster System one truck-mounted Dempster-Dumpster eliminates up to 10 conventional trucks because one Dempster-Dumpster services a great number of Dempster-Dumpster containers. These detachable containers, ranging in size up to 12 cu. yds., carry pay-loads equal to and greater than conventional truck bodies. They are built in a wide variety of designs best suited to handle any type of materials, be they bulky, light or heavy . . . solids or liquids . . . trash or rubbish. Containers are spotted at necessary materials accumulation points inside and outside buildings. The Dempster-Dumpster services one pre-loaded container after another.

In addition to saving thousands of dollars annually in tires, gas, oil, and truck maintenance, the Dempster-Dumpster System eliminates standing idle time by truck and crews . . . eliminates handling and re-handling of materials . . . and increases efficiency and cleanliness. It will pay you to investigate the Dempster-Dumpster System now! A product of Dempster Brothers, Inc.

One Dempster-Dumpster Services All Containers. . . All Designs. . . All Sizes

DEMPSTER BROTHERS, 590 Dempster Building, Knoxville 17, Tennessee

Over 10 years' continuous use of NEOPRENE by this oil-field equipment manufacturer . . .



Oil Center Tool Company

1812 AIRLINE DRIVE — HOUSTON 1, TEXAS — P. O. BOX 3081

O-C-T

February 21, 1950

E. I. du Pont de Nemours & Company, Inc.
Rubber Chemicals Division
Wilmington 98, Delaware

Gentlemen:

During the past ten years the Oil Center Tool Company has supplied the oil industry with a large number of Blow-Out-Preventers. Endless improvements are being made to meet new conditions in the field, however, Neoprene continues to serve in the regular pack-off element.

This pack-off must provide safety for crew and equipment in many drilling and work-over operations. It must seal perfectly against high pressures such as those found in squeeze jobs.

It is required to withstand the abrasive and deteriorating effects of drilling muds and continuous exposure to the elements.

Neoprene has continued to prove itself satisfactory for service under these conditions.

Very truly yours,

OIL CENTER TOOL COMPANY

R. K. Le Rouax, Chief Engineer

rkmd

. . . brings this comment Today . . .

★ The Oil Center Tool Company had been using neoprene for their blowout preventers and other equipment for some time when the above ad appeared in 1939. They chose neoprene because of its qualities, backed up by experience from *grueling use in the field*. And neoprene is still living up to these field conditions.

★ When you need rubber to meet the most exacting requirements, investigate Du Pont neoprene. Its combination of outstanding properties provides resistance to deterioration from contact with acids, alkalis, oils, grease and most chemicals. And what's more, neoprene withstands exposure to weathering, sunlight, extreme temperatures, abrasion and constant flexing. These and the many other advantages of Du Pont neoprene assure long, trouble-free service life in any product where neoprene is used. Specify it for your equipment needs. While Du Pont does not make any finished products of neoprene, we'll be glad to put you in touch with a supplier. Write to E. I. du Pont de Nemours & Co. (Inc.), Rubber Chemicals Division O-9, Wilmington 98, Delaware.

NEOPRENE

The rubber made by Du Pont since 1931

DU PONT

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BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

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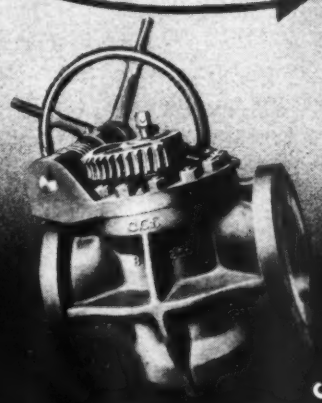
UNINTERRUPTED FULL FLOW



FULL PIPE AREA CYLINDRICAL PLUG...

Stands alone in its ability to minimize turbulence and change of velocity, without use of larger-than-pipe-size valves. Quick operation, if needed, no wedging, lubricated for long life and corrosion protection...why anything but an a.c.f. Lubricated Plug Valve.

CYLINDRICAL

a.c.f. FULL PIPE AREA **PLUG VALVES**

LUBRICATED

Representatives in more than 50 Principal Cities.

a.c.f. Valves are available in many types and sizes. Ask for catalog 1-OG. American Car and Foundry Company, 30 Church St., New York 8, N. Y

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CHEVROLET

The World's Most Popular Engine!
More truckers use Chevrolets than any other make. And one important reason is Valve-in-Head engine design. For 38 years Chevrolet has been the largest producer of valve-in-head engines — engines world famous for power, dependability and outstanding economy.

Lower Cost per Mile! Chevrolet's Valve-in-Head Loadmaster engine and Chevrolet's greater horsepower at the clutch add up to important advantages to truckers. They mean greater efficiency—they mean *bigger payloads at lower cost per mile!*

Better Buy . . . Better Resale! Low first cost coupled with dependability and economy make Chevrolet trucks *the buy*. Chevrolet trucks have led in demand and sales for the last eight consecutive truck production years . . . are far ahead this year, according to current registration figures. Here is proof of greater owner satisfaction . . . satisfaction which has made Chevrolet's higher resale value traditional across the nation.

Chevrolet Trucks
CUT YOUR COSTS ON EVERY HAUL!

Chevrolet heavy-duty trucks with Loadmaster engine actually deliver *more horsepower at the clutch* . . . more *net* horsepower—proved by certified ratings on engines used as standard equipment in conventional models of the five most popular makes, 13,000 to 16,000 lbs. G.V.W.* Here, then, is power to *move* big payloads . . . in a truck with strength to *carry* big payloads . . . and these add up to outstanding, all-around efficiency. You save on gas, oil and upkeep, cutting your costs on every haul! See your Chevrolet dealer—get the full story of Chevrolet leadership. **Gross Vehicle Weight*

CHEVROLET MOTOR DIVISION, *General Motors Corporation*
DETROIT 2, MICHIGAN

PLUS—Chevrolet Advance-Design Truck Features!

TWO GREAT VALVE-IN-HEAD ENGINES: the new Loadmaster and the improved Thriftmaster—to give you greater power per gallon, lower cost per load • THE NEW POWER-JET CARBURETOR: smoother, quicker acceleration response • DIAPHRAGM SPRING CLUTCH for easy-action engagement • SYNCHRO-MESH TRANSMISSIONS for fast, smooth shifting • HYPOID REAR AXLES—5 times more durable than spiral bevel type • DOUBLE-ARTICULATED BRAKES—for complete driver control • WIDE-BASE WHEELS for increased tire mileage • ADVANCE-DESIGN STYLING with the "Cab that Breathes" • BALL-TYPE STEERING for easier handling • UNIT-DESIGN BODIES—precision built.

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The SWING Is To UNIBOLT Hinged Scraper Traps

Opening the UNIBOLT Hinged Scraper Trap requires two simple operations: Release two bolts; swing the hinged Blanking Plug open. Just as quickly, you can reverse the operation: Swing the Plug shut and tighten the two bolts. No heavy lifting. No danger of injuries through dropping a heavy closure. This compact UNIBOLT Hinged Scraper Trap takes the place of heavy, multi-bolt blind flange closures and leaky-thread bull plugs. And in addition to its economy, safety, and operating convenience UNIBOLT gives you a better closure, a tighter closure with longer life.

UNIBOLT

Any line or unit that requires closures, such as strainers, blowdowns, scrubbers, mist removers, and similar pressure vessels, may be UNIBOLT-equipped to real advantage. Wherever a blind flange is applicable, a UNIBOLT Coupling with Blanking Plug will do the job better—seal tighter, reduce weight, and save time.

THORNHILL-CRAVER COMPANY • HOUSTON, TEXAS

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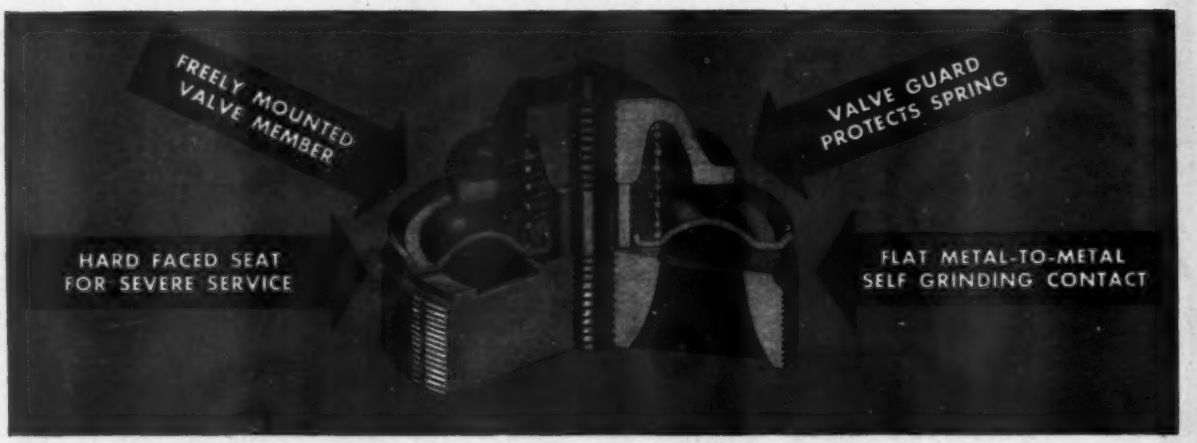
DURABLA

METAL PUMP VALVE UNITS
KEEP YOUR PUMPS IN SERVICE


FREELY MOUNTED VALVE MEMBER
VALVE GUARD PROTECTS SPRING
HARD FACED SEAT FOR SEVERE SERVICE
FLAT METAL-TO-METAL SELF GRINDING CONTACT

1 **THEY ARE SELF-GRINDING:** Durabla Valve Units*, utilizing the freely mounted arched construction valve member exclusive to Durabla, are self-grinding, as the flat portion of the valve member is in direct contact with the flat valve seat and is free to move about its axis, thus producing a constant self-grinding action.

2 **VALVE SEATS ARE HARD FACED FOR SEVERE SERVICE:** Providing a seat surface hardness of Rockwell C-48-52 (approximately 500 Brinnel) or more in special valves, Durabla Valve Units have a long record of effective service with FLUIDS CARRYING SUSPENDED ABRASIVE SUBSTANCES. The metal valve member effectively prevents the pitting or "pick-up" of abrasive substances sometimes occurring with valves made of other materials.

3 **VALVE SPRINGS AND VALVE STEMS ARE PROTECTED:** The Valve Guard protects the Valve Spring from ever compressing more than 50% of its length. The Valve Stem is protected against breakage by the free mounting of the Valve Member.

Economy, efficiency and adaptability, based on long established service records and exclusive design make Durabla Valves your guarantee of reliable, uninterrupted pump operation.

You can specify Durabla Valves when you order a pump, (many manufacturers use them as standard equipment), or you can order Durabla Valves to fit any type of reciprocating pump, (they come with drive-fit seats or threaded seats with or without a shoulder to suit the job).

TO AVOID "PUMP TROUBLES" SPECIFY DURABLA VALVES

Address DURABLA Engineering Department for information and bulletin: Reference OG-9

*Patent Numbers 2090486, 2117504

DURABLA MANUFACTURING COMPANY
114 LIBERTY ST. NEW YORK
BRANCHES IN PRINCIPAL CITIES. FOR CANADA REFER: CANADIAN DURABLA LIMITED, TORONTO

Anaconda heat exchanger tube advice is—

AUTHORITATIVE

Tube bundles for high pressure feed water heaters in central station power plant. Tube material: ANACONDA Cupro-Nickel. Coils fabricated by Carl Bobke, Coppersmith, Milwaukee, Wis. Feed water inside tubes, steam outside bled from plant turbines.

here's why—

For years we have conducted laboratory and field investigations of condenser and heat exchanger tube materials, structure, applications and performance.

The data files, built up during this long period, are exhaustive. We have dependable facts and figures on tube materials found practical in a wide variety of applications.

Backed by this definite, reliable information, Anaconda Condenser and Heat Exchanger Tube Engineers are confidently able to help you select tubes that will serve you best.

Let us undertake a study of your heat exchange problems at your convenience. There's no obligation, of course. The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario.

50122

For efficient heat transfer ANACONDA®

HEAT EXCHANGER TUBES

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The New Alfco Model 350

INDUSTRY'S BIGGEST WHEELED PORTABLE

DRY CHEMICAL ENGINE

It is one of the most efficient, fast-acting, fire extinguishing units which Alfco engineers have yet devised. Containing 350 lbs. of Alfco Dry Chemical, the smothering action of its deadly discharge on fire is sensational.

Blistering hot fires of considerable proportions which at first may appear too monstrous for control, can be quickly extinguished.

Its discharge pattern is fan shaped. The density of the dispersion of the Dry Chemical is total! Effective range is 20 to 25 ft. Expelling agent is *dry* nitrogen. Discharge time is about 1 min., 15 sec. Dry Chemical is nontoxic, noncorrosive, a non-conductor of electricity and will not freeze.

Approved by Underwriters and Factory Mutual Laboratories. Rating B, C.

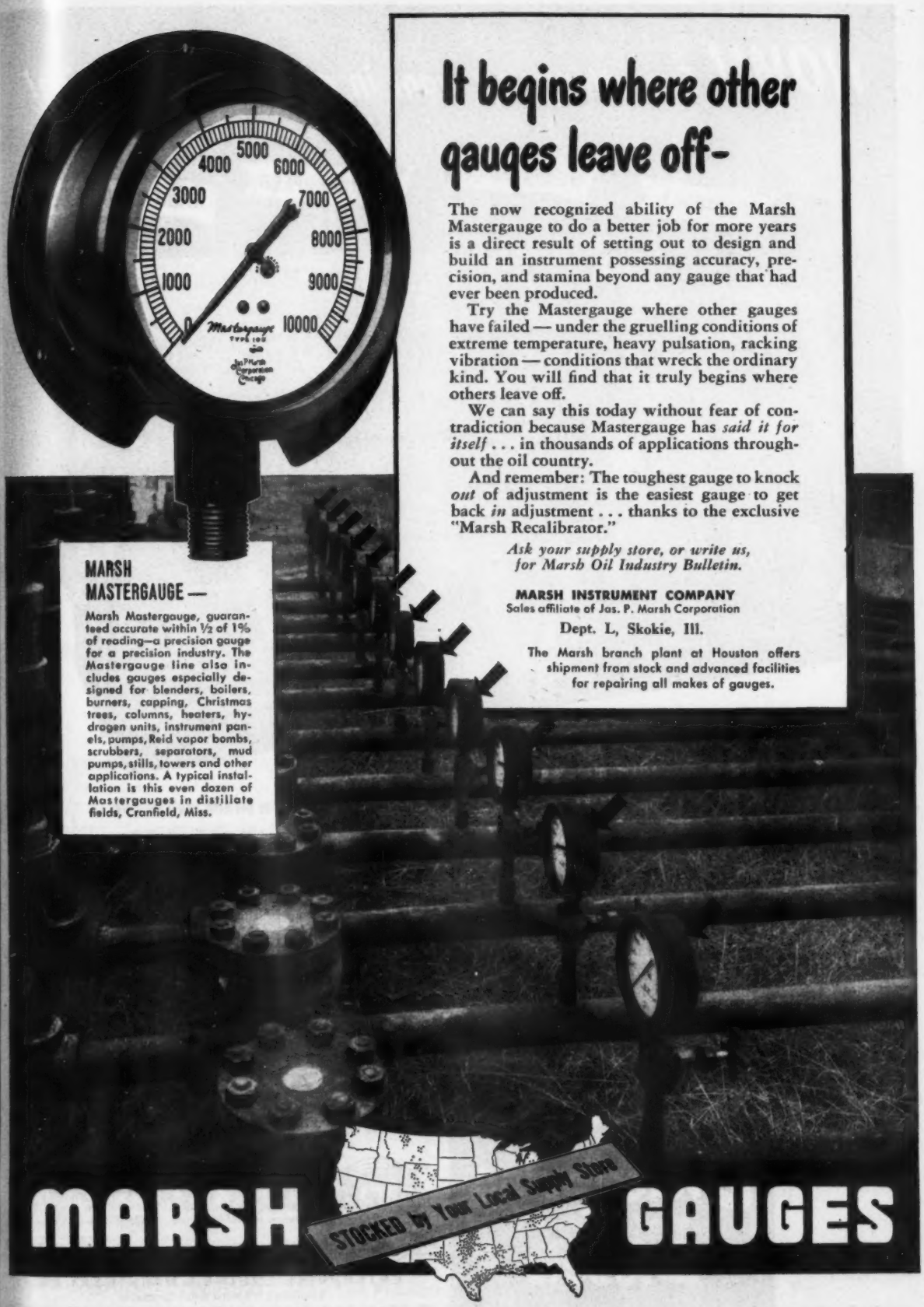
Write for illustrated literature

OUR *2nd Century of Leadership in* FIRE PROTECTION

AMERICAN-LAFRANCE-FOAMITE *Corporation*

ELMIRA · NEW YORK · U.S.A.

ALFCO



It begins where other gauges leave off-

The now recognized ability of the Marsh Mastergauge to do a better job for more years is a direct result of setting out to design and build an instrument possessing accuracy, precision, and stamina beyond any gauge that had ever been produced.

Try the Mastergauge where other gauges have failed — under the gruelling conditions of extreme temperature, heavy pulsation, racking vibration — conditions that wreck the ordinary kind. You will find that it truly begins where others leave off.

We can say this today without fear of contradiction because Mastergauge has *said it for itself* . . . in thousands of applications throughout the oil country.

And remember: The toughest gauge to knock *out* of adjustment is the easiest gauge to get back *in* adjustment . . . thanks to the exclusive "Marsh Recalibrator."

Ask your supply store, or write us, for Marsh Oil Industry Bulletin.

MARSH INSTRUMENT COMPANY
Sales affiliate of Jas. P. Marsh Corporation
Dept. L, Skokie, Ill.

The Marsh branch plant at Houston offers shipment from stock and advanced facilities for repairing all makes of gauges.

MARSH MASTERGAUGE —

Marsh Mastergauge, guaranteed accurate within ½ of 1% of reading—a precision gauge for a precision industry. The Mastergauge line also includes gauges especially designed for blenders, boilers, burners, capping, Christmas trees, columns, heaters, hydrogen units, instrument panels, pumps, Reid vapor bombs, scrubbers, separators, mud pumps, stills, towers and other applications. A typical installation is this even dozen of Mastergauges in distillate fields, Cranfield, Miss.

XUM

NOW! Everything you want in a real WORK engine!

ENTERPRISE M SERIES DIESELS

Designed and developed to meet the demand for tough and continuous operation at medium speeds, Enterprise M Series Diesels in 3, 4 and 6 cylinder models are now available for the most economical solution to your power requirements using a wide range of low grade fuels. Compact, portable or completely contained if desired, these units deliver 68 to 240 BHP at conservative speeds of 450 to 750 RPM. They are WORK engines, capable of thousands of hours in demanding service, at low operating cost, with minimum maintenance and servicing requirements. When you compare, feature for feature, you're sure to make your next diesel a medium speed, high capacity Enterprise M engine—for years of the smoothest power you've ever enjoyed.

If you want 68 to 240 BHP, you'll get more for your money with an Enterprise 3, 4, or 6 cylinder M Series Diesel.

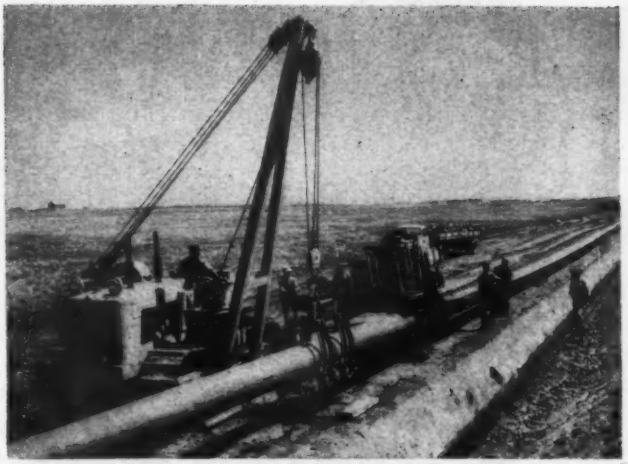
- 8" bore x 10" stroke
- Compact, medium speed, heavy duty
- Easy starting, air or electric
- Operates on low cost non-premium fuels
- Low fuel consumption
- Smooth, quiet, clean operation

Enterprise STATIONARY Diesels

Write for new Enterprise M Series Bulletin No. M-16, or call your nearest Enterprise office for complete information.

ENTERPRISE ENGINE & MACHINERY CO.
A Subsidiary of General Metals Corporation
18th & Florida Streets, San Francisco 10, California • Offices in Principal Cities

Canada's GIANT NEW PIPE LINE...



▲ Koppers Bitumastic Enamel being machine-applied.

▼ When completed, this giant line of the Interprovincial Pipe Line Company will carry oil from Edmonton, Alberta, to Winnipeg, Regina and tankers on the Great Lakes. It will require 64,330,000 gallons of oil to fill this line.

protected by KOPPERS BITUMASTIC ENAMEL

● From one end to the other, the new 1,150-mile line of the Interprovincial Pipe Line Company will be protected against corrosion by Koppers Bitumastic® 70-B Free-Flowing Enamel. This giant outlet will carry the production of Alberta's oil fields to Winnipeg, Regina and Ontario markets.

Koppers Bitumastic 70-B Enamel, machine-applied over a coat of Koppers Bitumastic 70-B Priming Solution, will protect 450 miles of 20″ pipe, 340 miles of 16″ pipe, and 360 miles of 18″ pipe. Highly-corrosive soils, river crossings, cold weather—all types of rugged conditions—will test the effectiveness of the protective coating.

Many of America's pioneer oil and gas pipe lines—laid in the twenties—are still giving good service today, thanks to the effective protection of Koppers Bitumastic Enamels. And hundreds of applications of Koppers Bitumastic Enamels have given Koppers engineers unequalled experience in pipe-line protection—experience that can help you.

Give your pipe lines *assured* protection against corrosion by specifying "Koppers Bitumastic Enamel." Get in touch with your Koppers representative for complete details and estimates.

Why Bitumastic Enamels give lasting protection

Processed from a base of coal-tar pitch, they are impervious to moisture . . . chemically resistant to soil elements. They make a tight bond with the pipe . . . do not disintegrate with age . . . maintain continuously high electrical resistance.

KOPPERS BITUMASTIC® ENAMELS

REG. U.S. PAT. OFF.

KOPPERS COMPANY, INC., Tar Products Division, Dept. 903T, Pittsburgh 19, Pa.

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FIRE-PROOF!

inside and out!

CMH REX-FLEX FIRE-PROOF FLEXIBLE METAL HOSE

FOR: Fuel and Process Lines and Fire Protection Systems

For services where the combustibility of materials handled demands that flexible connections be resistant to internal or external fire, CMH manufactures a truly *fire-proof* flexible metal hose. Already widely used in critical applications, CMH REX-FLEX Fire-Proof Flexible Metal Hose has been subjected to the severest tests. Its use in processing plants and fire protection systems will provide new highs in safety not available in standard type hose assemblies.

CMH REX-FLEX Fire-Proof Flexible Metal Hose is available in sizes from 5/16" to 6" I.D. with a choice of standard fittings. Write for latest data and specifications for your requirements.

Undamaged after 10 hours of continuous internal fire . . .

In certified tests, CMH Fire-Proof Metal Hose was subjected to 10 hours continuous internal fire — without damage! It also withstood an external flame of over 2000°F. for over fifteen minutes—again without failure!

Here is a degree of safety that cannot be found in other types of hose construction!

Flexon identifies CMH products that have served industry for over 48 years.

CHICAGO METAL HOSE Corporation

1345 S. Third Avenue • Maywood, Illinois • Plants at Maywood, Elgin and Rock Falls, Ill.
In Canada: Canadian Metal Hose Co., Ltd., Brampton, Ont.

CMH

ONE DEPENDABLE SOURCE
for every flexible metal hose requirement

Convoluted and Corrugated Flexible Metal Hose in a Variety of Metals • Expansion Joints for Piping Systems
Stainless Steel and Brass Bellows • Flexible Metal Conduit and Armor • Assemblies of These Components

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For all your Meters, Controls, Recorders..

ROCKWELL CHART DRIVES

NEW DEPENDABILITY, ECONOMY, CONVENIENCE IN MECHANICAL TIMING

STANDARD TYPE
For Replacement Service

Furnished with Adaptors to Fit Practically Any Instrument Case. Turrets Give Up To 11 Rotation Speeds

You can save money on inventory by standardizing on Rockwell chart drives for all your instruments. You need stock only two basic Rockwell models plus a representative selection of inexpensive adaptors and turret speed changers. The adaptors will correctly position the drive in any instrument while the turrets will provide up to 11 different rotation speeds on the same drive.

STANDARD DRIVE FEATURES

Dust proof, moisture proof case. Heavier mainspring and winding stem minimize principal causes of failure. Fitted with oil-sealed bearings, a single winding stem. Two basic models—8-day wind and 31-day wind. Turrets provide selection up to 11 speeds on one drive.

MIDGET DRIVE
obtainable on specification in most instruments

You can specify Rockwell Midget drives in instruments made by any manufacturer. The small size of the Midget allows more room for the other controls within the case and makes all the component parts readily accessible for service. Midget drives snap into a mounting ring which may be positioned on bosses or on adaptors to fit into any instrument case. In no other drive will be found the Rockwell combination of size, versatility, and high quality.

MIDGET DRIVE FEATURES

Made in three parts: the case, including mainspring and gears, a detachable escapement sealed in transparent plastic and a mounting ring. Winds through the chart arbor. Two models—8-day wind, 24-hour rotation and 24-hour wind, 24-hour rotation. Patented turret converters which snap on the main arbor provide a selection of 11 speeds on 8-day model.

Attractive factory repair program— WRITE FOR BULLETIN NO. 1079

ROCKWELL MANUFACTURING COMPANY
Pittsburgh 8, Pa.

Boston Chicago Columbus Houston Kansas City Los Angeles New York Pittsburgh San Francisco Seattle Tulsa

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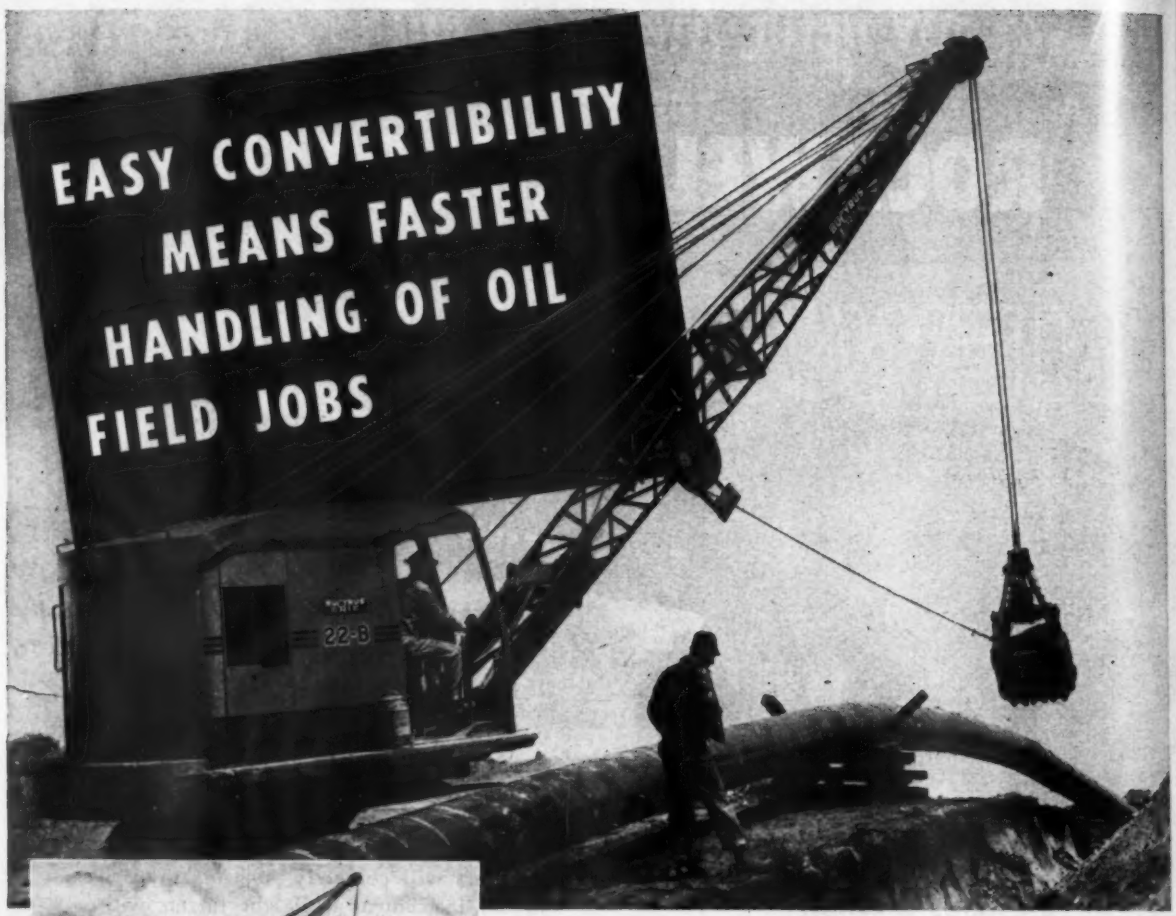
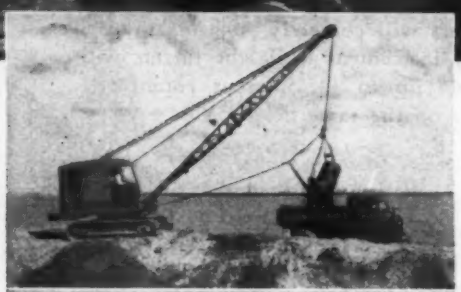
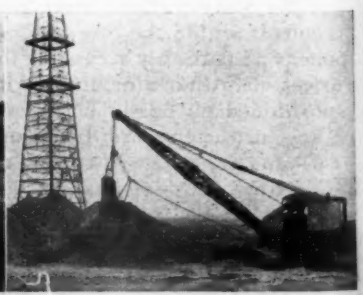
EASY CONVERTIBILITY MEANS FASTER HANDLING OF OIL FIELD JOBS





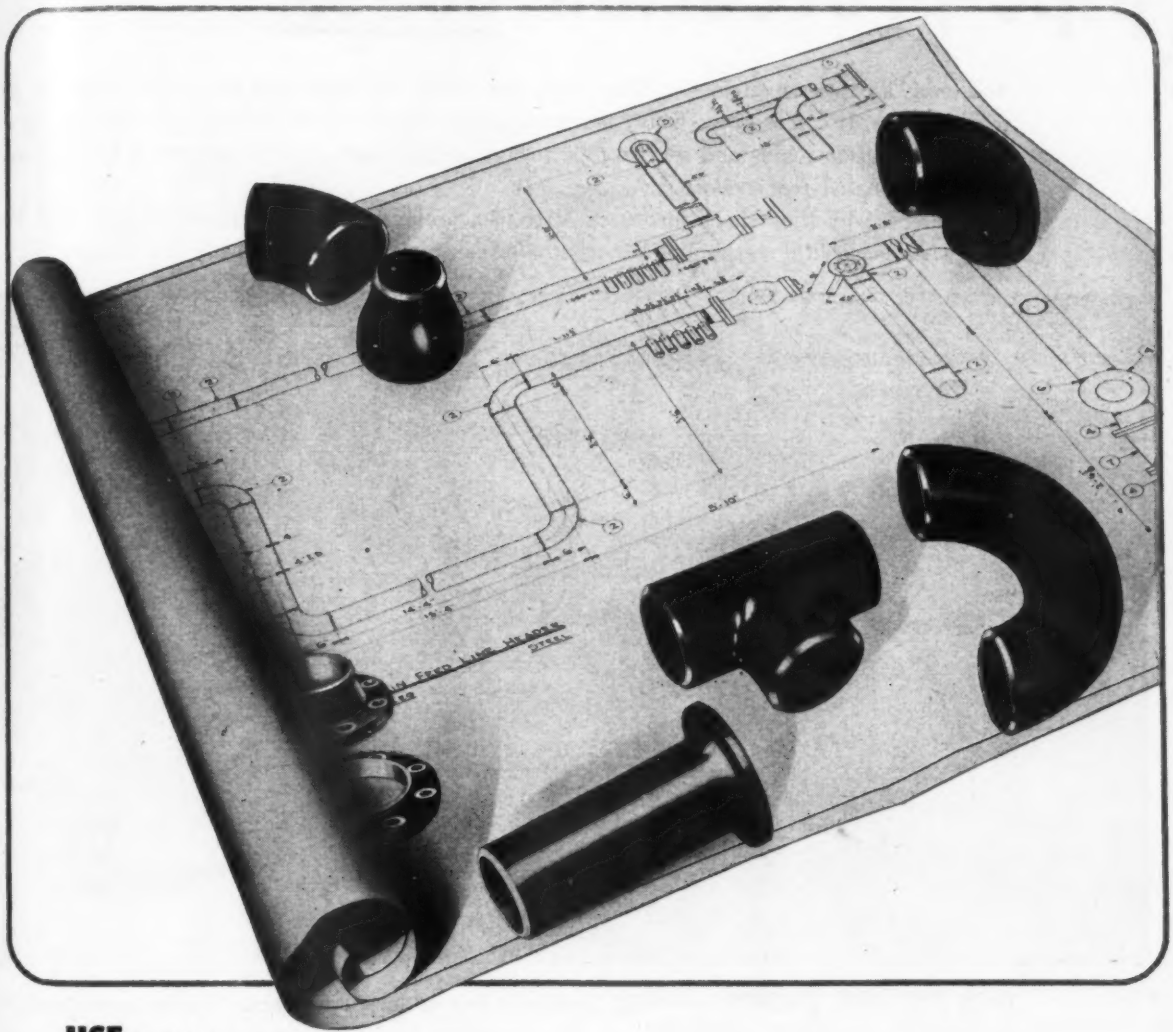


BUCYRUS-ERIE engineering brings you in-the-field convertibility at its most effective and simple level. You need do little more than switch booms to take full advantage of the front end that best fits your oil field job. Every versatile unit has the performance characteristics you need: fast-cycle shovels; accurate and stable cranes and clamshells; smooth-working long range draglines; dragshovels with powerful digging strokes. And outstanding dependability adds to the overall economy you'll experience with Bucyrus-Eries doing the work. See your Bucyrus-Erie excavator distributor for full details on Bucyrus-Erie gasoline, diesel and single motor electric ⅜ to 4 yard excavators.

BUCYRUS-ERIE COMPANY • South Milwaukee, Wisconsin

219E50

TO DO A BETTER PIPING JOB . . .



USE . . .

GLOBE PRECISION PROCESS SEAMLESS WELDING FITTINGS

When you specify and use Globe Welding Fittings you have the product of an organization with unusually broad metallurgical experience. Globe's precision-process method of production reaches back to the manufacture of the Globe seamless tubes themselves which are the "raw material" of Globe welding fitting fabrication.

GLOBE STEEL TUBES CO., Milwaukee 4, Wisconsin

Chicago • Minneapolis • Cleveland • Detroit • New York • Philadelphia St. Louis • Tulsa • Houston • Denver • San Francisco • Glendale, Cal.

Producers of Globe seamless stainless steel tubes — Gloweld welded stainless steel tubes — carbon — alloy — seamless steel tubes — Globeiron seamless high purity ingot iron tubes — Globe Welding Fittings.

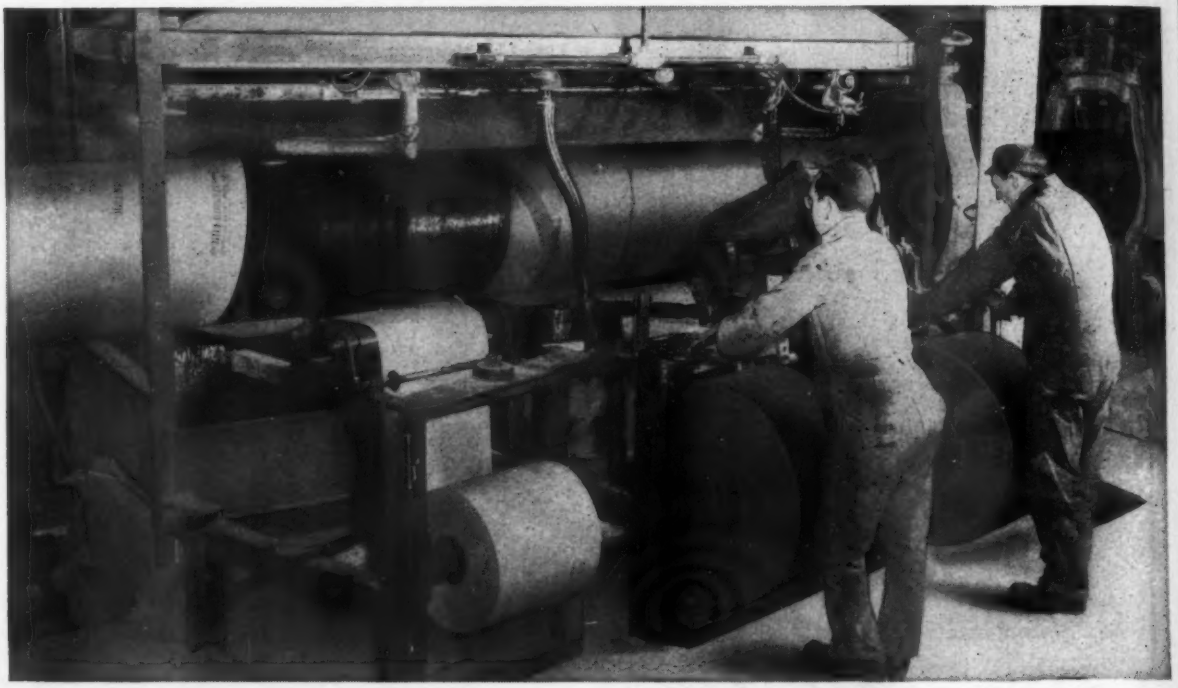
Send for the Globe Welding Fittings Catalog—and look to Globe as a preferred source of supply.

XUM

How to cut your pipe-protection costs:

Ask today's corrosion engineers. They'll tell you where the *major* cost of a pipe-protection job too often lies. It comes in the heavy *maintenance* expense. They've learned that with *all* pipe—from distribution mains and service pipe to long transmission lines—costs must be measured in *years of trouble-free service.*

That is why they check into *every stage* of a protection process before placing a job. For only when each vital step is skillfully *controlled* can pipe resist every agent of corrosion.



THIS PICTURE SHOWS how Hill, Hubbell's heavy-duty equipment applies any standard specification of coating and wrapping. All operations, regardless of number or type of layer, are done *simultaneously*. Only this factory method can guarantee positive, uniform bonding—so essential to *lasting* resistance against corrosion.

This modern, efficient machine and its skilled operators are indicative of how Hill, Hubbell controls *every* stage of pipe conditioning and application. It helps explain why so many corrosion engineers insist on Hill, Hubbell-protected pipe for the *long-range* service that keeps protection costs low.

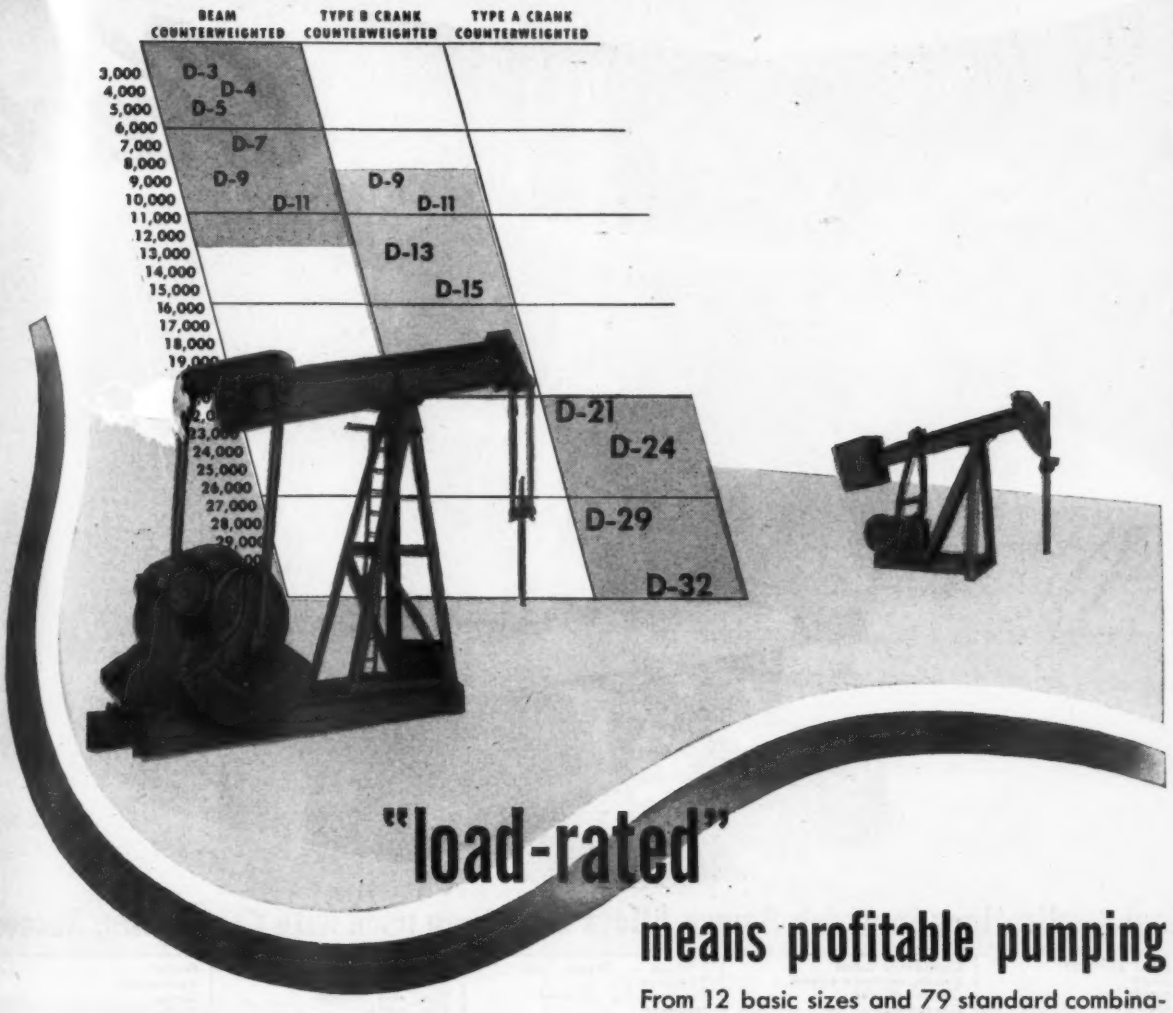
Hill, Hubbell and Company

Division of GENERAL PAINT CORPORATION

Headquarters: 3091 Mayfield Road, Cleveland 18, Ohio

For a Quarter Century the Pioneer in Pipe Protection

XUM



"load-rated" means profitable pumping

From 12 basic sizes and 79 standard combinations, you can readily select the National Pumping Unit to do the job efficiently, economically. No need to pay for too much capacity, nor limp along with an undersize unit.

You get a better pumping unit in a National . . . rugged, full-functional construction provides maximum rigidity and strength at a minimum of unit weight . . . long, trouble-free life is provided by needle-type anti-friction bearings on pitmans and saddles . . . jig-welded construction assures positive alignment for rapid parts interchangeability and minimum wear.

Built in API Beam Loading Ratings from 3200 to 32,400 pounds, National Pumping Units are available in your choice of beam or crank counterweight types.

Write for bulletins and specifications on the sizes you require.

THE NATIONAL SUPPLY COMPANY

GENERAL SALES OFFICES: TOLEDO, OHIO

NATIONAL BLUE PRODUCTS

DIVISION OFFICES: CASPER; FT. WORTH; PITTSBURGH; TULSA; TORRANCE.

CANADA: THE NATIONAL SUPPLY COMPANY, LIMITED, ROOM 202, ALBERTA BLOCK, CALGARY, ALBERTA.

EXPORT: NATIONAL SUPPLY EXPORT CORPORATION, 30 ROCKEFELLER PLAZA, NEW YORK, N. Y., U. S. A.; RIVER PLATE HOUSE, 12 SOUTH PLACE, LONDON E.C.2.

NATIONAL OIL FIELD MACHINERY AND EQUIPMENT . . . SPANG PIPE . . . SUPERIOR & ATLAS ENGINES

Typical Applications in which Ampco Alloys have been used with Cost-Saving Success

Absorption columns
Acetylators
Acid chain
Agitators
Autoclaves
Baskets
Bearings
Beater bars
Bellows
Bolts and nuts
Brazing rod
Brine coils
Bubble caps and trays
Calandrias
Condenser shells
Condenser tubes
Condenser tube sheets
Control valves
Conveyors
Coolers
Crystallizers
Dephlegmators
Digesters
Ejectors
Evaporators
Evaporator tubes
Extractors
Fabricated assemblies
Filters and filter screens
Filter presses
Fittings — forged, cast
Forgings
Fractionating columns
Hangers
Heat exchangers
Heater coils
Hooks
Injectors
Instrument cases and elements
Kettles
Line hardware
Meter cases
Mixers
Pans, evaporator
Perforated plate
Pickling baskets
Pipe and fittings
Plug cocks
Pressure vessels
Pumps
Reboilers
Retorts
Rivets
Safety tools
Screens
Screws, conveyor
Sludge burners
Springs
Stills
Studs
Sucker rod
Tanks
Tools, safety
Towers
Trays, fractionating
Tubes and tubing
Vats
Valves
Welding rod
Weld tubing
Wire
Woven wire cloth

Chemical Agents and the Applicability of AMPCO Alloys

Acetate Solvents (Pure)	E
Crude	G
Acetic Acid	
Crude	E
Vapors	E
Acetic Anhydride	E
Acetone	E
Acetylene	NR
Alcohols	E
Aluminum Fluoride	G
Aluminum Sulfate	G
Aluminum Hydroxide	E
Ammonia Gas	
Dry	G
Wet	NR
Ammonium Chloride	NR
Ammonium Hydroxide	NR
Ammonium Nitrate	F
Ammonium Phosphate	F
Ammonium Sulfate	F
Amyl Chloride	E
Asphalt	E
Barium Chloride	E
Beer	E
Beet Sugar Liquors	E
Benzene or Benzol	E
Borax	E
Boric Acid	E
Brine	E
Butane, Butylene	E
Butadiene	E
Butyric Acid	E
Calcium Bisulfite	G
Calcium Hydroxide	G
Calcium Hypochlorite	F
Cane Sugar Liquors	E
Carbolic Acid	E
Carbon Dioxide	
Dry	E
Wet	G
Carbon Disulfide	E
Carbon Tetrachloride	E
Caustic Soda	E
Chlorine	
Dry	G
Wet	NR
Chloroform	E
Chromic Acid	NR
Citric Acid	E
Copper Sulfate	NR
Crude Oils — Sour	G
Esters	E
Ethers	E
Ethylene Glycol	E
Ethyl Sulfate	E
Ferric Chloride	NR
Ferric Sulfate	NR
Formaldehyde	E
Formic Acid	E
Freon	E
Furfural	E
Gasoline	E
Gelatine	E
Glucose	E
Glycerine	E
Hydrocarbon Gases	E
Hydrochloric Acid	
to 5%	G
to 10%	F
(see Muriatic)	
Hydrocyanic Acid	NR
Hydrofluoric Acid	G
Hydrogen Fluoride (Dry)	E
Hydrogen	E
Hydrogen Peroxide	F
Hydrogen Sulfide	
Wet	NR
Dry	F
Lacquers and Lacquer Solvents	E
Lactic Acid	E
Magnesium Chloride	E
Magnesium Hydroxide	E
Magnesium Sulfate	E
Malt Beverages	E
Mercuric Chloride	NR
Mine Water (Sulfate)	E
Molasses	E
Monochlorobenzene	E
Muriatic — Cold, Commercial	G
Naptha	E
Natural Gas	E
Nickel Chloride	G
Nickel Sulfate	G
Nitric Acid	NR
Nitrogen (Dry)	E
Oleic Acid	E
Oxygen	E
Paint Vehicles (Except Soya-Oil)	G
Palmitic Acid	E
Petroleum Oils	
Sour	G
Refined	G
Phenol	E
Phosphoric Acid	E
Pickling Acid (except Nitric Chromic)	E
Potassium Chloride	E
Potassium Cyanide	NR
Potassium Hydroxide	F
Potassium Sulfate	E
Potash Crudes	E
Propane	E
Shellac	E
Soaps	E
Soda Ash (Sodium Carbonate)	G
Sodium Bicarbonate	E
Sodium Bisulfate	E
Sodium Carbonate	E
Sodium Chloride	E
Sodium Cyanide	NR
Sodium Hydroxide	E
Sodium Nitrate	G
Sodium Perborate	E
Sodium Peroxide	F
Sodium Phosphate	
Alkaline	E
Neutral	E
Acid	G
Sodium Silicate	E
Sodium Sulfate (Soda Cake)	E
Sodium Sulfide	NR
Sulfur	F
Sulfur Chloride	NR
Sulfur Dioxide	
Dry	G
Wet	G
Sulfuric Acid	
5%)	E
10%)	E
25%) Up to Boiling	E
35%)	E
50%)	E
Sulfuric Acid Sludge	E
Sulfurous Acid	G
Tannic Acid	G
Tartaric Acid	E
Toluene or Toluol	E
Tri Chlorethylene	E
Tri Sodium Phosphate	E
Turpentine	E
Varnish	E
Vegetable Oils	E
Water	
Fresh	E
Salt (includes Polluted Harbor)	E
Xylene	E
Zinc Chloride	G
Zinc Sulfate	E

These ratings may usually be interpreted as follows:

E — Excellent
IPY Penetration
< 0.006"

G — Good
IPY Penetration
< 0.016"

F — Fair
IPY Penetration
< 0.050"

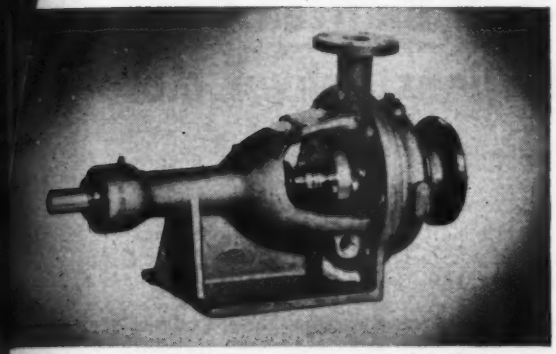
NR — Not Recommended
IPY Penetration
Over 0.050"

In using this data, it should be understood that these are results of specific tests and are indicative of those conditions under which the tests were run, and are a basis for recommendation, but not for guarantee.

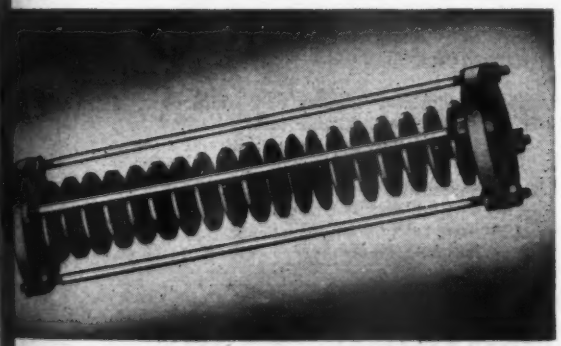
AMPCO

Your Corrosion Problems ...use Ampco Alloys

...these unique properties have proved to be the best answer to many process equipment problems



Ampco Centrifugal Pumps —Here—for the first time in pump manufacturing history — is a "production-built" and "production-priced" pump to handle acids, alkalies, and other corrosive agents hitherto requiring specially built pumps. The Ampco single-stage, single-suction centrifugal pump offers long life, high efficiency and low maintenance costs through the combination of correct design and properly selected materials.



CORROSION TESTING—Types of Test Specimens — A complete stock of test specimens of a wide variety of materials is kept ready for mounting on racks. Several forms of racks are available for tests in atmospheric locations, pipe lines, tanks or other pressure vessels. When requesting test specimens please outline conditions under which test is to be conducted so that we may supply the most suitable form.

1. High resistance to corrosion
2. High tensile strength
3. High physicals at extreme temperatures
4. High strength to weight ratio
5. High impact and fatigue values
6. High wear-resistance — to erosion — corrosion — cavitation, etc.
7. High compressive strength
8. High modulus of elasticity

Designers and plant engineers in the process industries are turning to Ampco Alloys more and more frequently — because of the outstanding savings offered by their long-lasting qualities.

Costs are reduced in three ways: 1. Minimum down time, 2. Minimum product loss from parts failure, and 3. Minimum maintenance and replacement expense.

Study the list of time-proven applications and the Ampco applicability chart and apply this data to your own needs. Plan your own economies now by specifying Ampco Bronze Alloys for corrosive and erosive media handling. Write today for recommendations and complete information.

★ ★ ★

Ampco aluminum bronzes are available in a number of grades to meet your exact requirements in any form you need: rolled sheet or plate, sand or centrifugal castings, forgings or extrusions . . . pipe and fittings. Also, Ampco's arc-welding electrodes, corrosion-resistant centrifugal pumps and plug valves.

Free . . .
Process Industries Bulletin — 16 pages of money-saving information.

AMPCO

Ampco Metal, Inc.
Milwaukee 46, Wisconsin
West Coast Plant *Burbank, California*

Ampco Metal, Inc., Dept. OG-9, Milwaukee 46, Wis.

Send me your free bulletin, giving full information on the application of Ampco Alloys in the Process Industries.

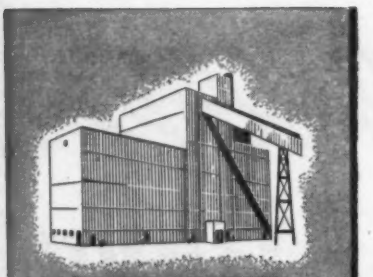
Name..... Title.....

Company.....

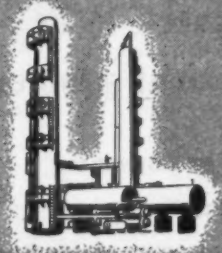
Company Address.....

City..... ( ) State.....

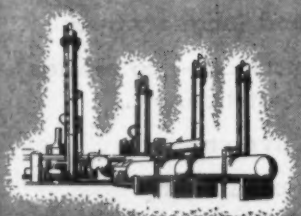
XUM



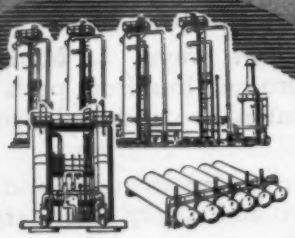
POWER DIVISION



CHEMICAL DIVISION

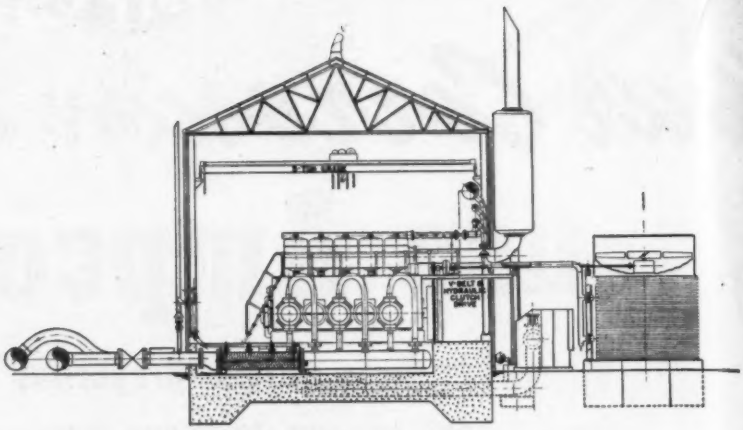


PETROLEUM DIVISION



NATURAL GAS DIVISION

DESIGN ENGINEERING and CONSTRUCTION for INDUSTRY



Pritchard-Built Unitized Gas Compressor Stations Deliver More Horsepower Per Dollar!

The *unitized* gas compressor station shown above in cross section, is Pritchard's answer to the Natural Gas Industry's demand for increased efficiency and flexibility at lower cost per compression horsepower.

In this design, each engine compressor unit is made as nearly an independent unit as possible, with its own radiator-type jacket water cooler, oil to gas cooler and water circulating pump. As the line load varies, independent units may be added to or removed from service at will.

You are invited to make use of Pritchard's diversified experience in the Gas Engineering field in the design, engineering and construction of *modern* compressor stations or other facilities.

These Pritchard GAS ENGINEERING Services Are Available To You

- Compressor stations and additions
- Pressure maintenance units
- Desulphurization, amine type
- LP-Gas Installations
- Conditioning and treating
- Cooling and heat transfer
- Removal of liquids and dust
- Gasoline plants

For Complete Information on Pritchard's Services Write for *FREE* Bulletins!

NATIONAL CONSTRUCTORS ASSOCIATION MEMBER

J.F. Pritchard & Co.

DESIGN • ENGINEERING • CONSTRUCTION

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HOUSTON • ST. LOUIS • CHICAGO • PITTSBURGH • TULSA • NEW YORK

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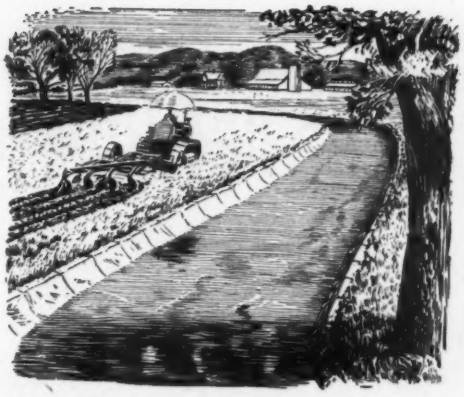
To help keep planes safe—a "Peak Temperature Indicator." This device, attached to motors, tells pilots instantly if any cylinder begins to heat up dangerously.



To help save the West's water—an inexpensive irrigation ditch lining. It's made by coating paper or aluminum foil with asphalt and keeps water from being lost into the ground.

To help protect diesel locomotives — a special detector and alarm which warns engineers if water leaks into the lubricating oil. Engines can be shut down quickly before expensive damage occurs.

Three new developments in Standard's laboratories

We picked these three developments to tell you about because they will probably never be manufactured by Standard of California.

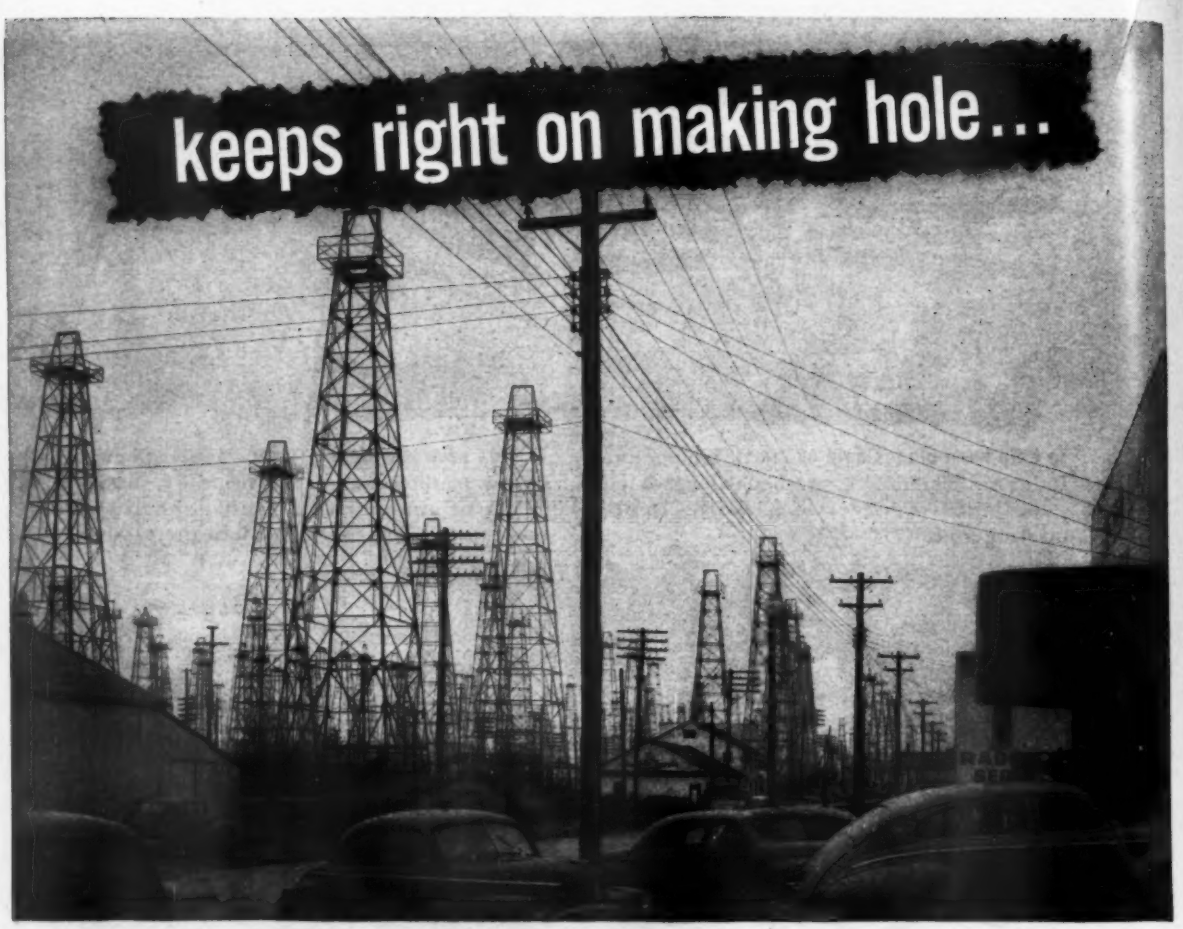
Although we developed them, looking for ways to help some of our customers meet special problems, we expect to turn them over to other companies to produce. And this illustrates a point...

Everything we discover that can possibly benefit you is brought to you in some way ...even when the development leads us far outside our own field. And when we turn up a practical way to improve a petroleum product, we make prompt use of it and, in many cases, make it available to other companies under license.

Research at Standard is a vital, progressive force. It has called for an investment of more than $35,000,000 in the last ten years, but its results have been immeasurable...not only in terms of better products but in the creation of new jobs and greater opportunity for our own people and those in many other industries.

STANDARD OIL COMPANY OF CALIFORNIA

plans ahead to serve you better



WAUKESHA *Diesel Six*

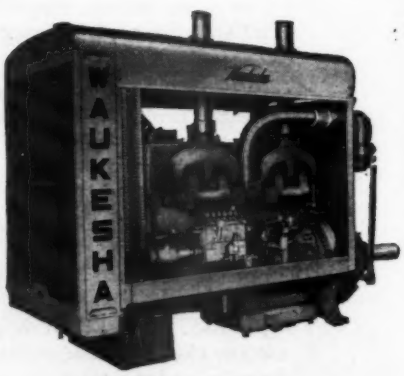
SUPER-DUTY OIL FIELD UNIT ★

...the postwar Diesel for deep drilling. Special Diesel design characteristics are combined with all the wartime-proved materials and features by Waukesha's 40 years' engine building know-how. The result is a super-duty six power plant that keeps your costs down while it keeps right on making hole.

Rugged and ready for heavy duty, yet fast, flexible and smooth—plus the same lively acceleration you have been getting with your gas engines. Easy starting, too...even in cold weather...with either the Waukesha gasoline starting engine or electric system.

Clean burning—for high fuel economy. Its patented Diesel combustion chamber, found only in Waukesha Diesels, burns all "high speed diesel fuels" with cetane values of 45 or above.

Operating on the four-cycle principle, its wet cylinder sleeves, precision bearings, simple overhead valve mechanism and other operating and maintenance features of familiar types make this Diesel easy to understand and to service. Send for Bulletin 1418.



SUPER-DUTY DIESEL SIX
(Model 6-WAKDU)
OIL FIELD POWER UNIT
six cyl. 6¼ in. bore x 6½ in. stroke, 1197 cu. in. displ., 190 hp. max. at 1300 rpm.

WAUKESHA MOTOR COMPANY, WAUKESHA, WIS., NEW YORK, TULSA, LOS ANGELES

extreme flexibility

Brown Fintube Sectional Heat Exchangers *are easily adaptable to changes in duty*

● You'll get almost unlimited flexibility to meet changes in duties, plant re-arrangements, etc., with Brown Fintube Sectional Heat Exchangers. The banks can be changed over *easily* and *quickly,* to operate *efficiently* on almost any *new* and *different* duty. You simply add a few sections, remove a few sections, or change the series-parallel manifolding.

For the utmost in efficiency and economy use Brown's proven, welded fintube heat exchangers throughout your plant. Estimates and quotations furnished promptly. *Write for Bulletin No. 481.*

BROWN FINTUBE'S 8 *advantages*

EXTREME FLEXIBILITY
Easily Adapted to Changes in Duty

NO OBSOLESCENCE
Avoiding Waste and Expense

FLANGED HEAD END ASSEMBLY
Eliminating Ground Joint Seals

EASY MAINTENANCE
Using Only Common Tools

CONTINUOUS OPERATION
No Shut-Downs For Cleaning

REDUCED STORES REQUIREMENT
Minimizing Investment and Handling

QUICK DELIVERY
Only a Few Hours in Emergency

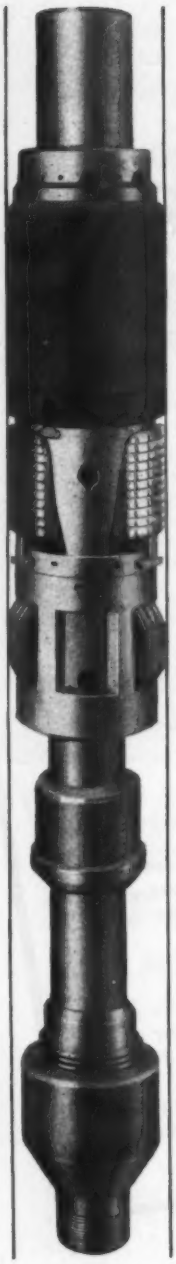
INCREASED CORROSION ALLOWANCE
Longer Tube Life

THE BROWN FINTUBE CO.
ELYRIA, OHIO

SECTIONAL HAIRPIN HEAT EXCHANGERS

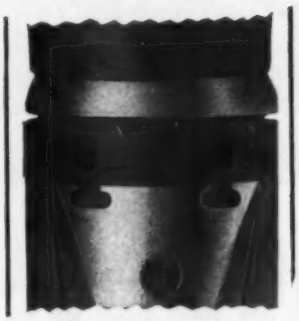
XUM

HERE IS YOUR PACKER



The WILSON Type "MB" METAL BLOCK PACKER

Set



Going in Hole

The "heart" of any Packer is the element — and 90% of Packer failures are caused by the element failing to "Pack-off" and hold.

In the Wilson types "MB" Metal Block Packer, the element *cannot "cold flow"*, no matter how great your hydrostatic head. A "Metal Block" of segments totally confines the rubber element between the casing, the top of the "Metal Block" and the mandrel of the Packer.

In going-in and coming-out of the hole, the metal block is retracted to the same diameter of the packer. In setting the Packer, the segments expand against the casing at the same time as the slips are set.

On the "deep ones" run a Wilson type "MB" Metal Block Packer —and save time and expense— for it will "hold".

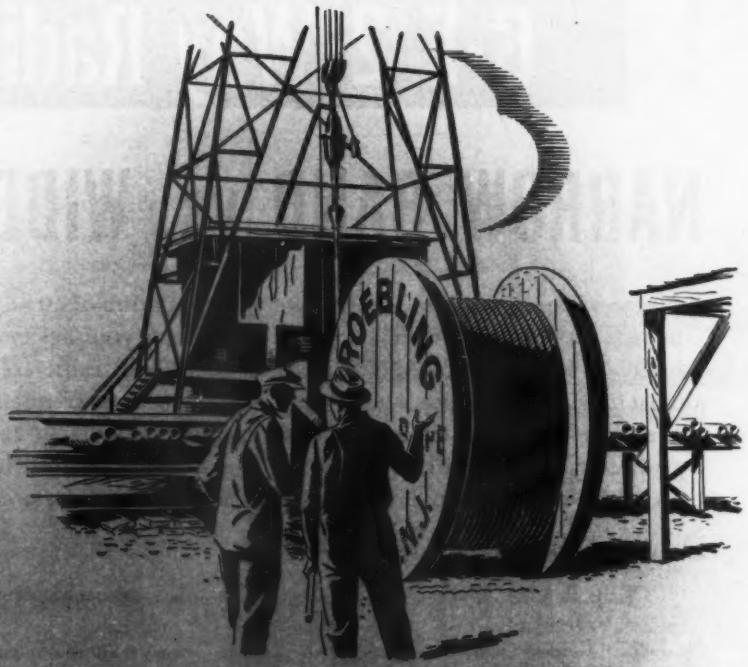
If your Supply Store does not have this outstanding Packer — write

WILSON FOUNDRY & MACHINE CO.

1417 ELYSIAN ST.

HOUSTON, TEXAS

As rotary drilling lines, Roebling 6x19 Preformed "Blue Center" Steel Wire Rope with Independent Wire Rope Core has demonstrated extra life on the job and substantial dollar savings.



For rope research and developments that help you save...

Today it's Roebling!

JOHN A. ROEBLING'S SONS COMPANY, TRENTON 2, NEW JERSEY

YEAR BY YEAR, industry makes new and more stringent demands upon wire rope . . . and Roebling leads in developing types that meet these demands with utmost efficiency and economy.

Take Roebling Preformed "Blue Center" Wire Rope with Independent Wire Rope Core!

No finer rope has ever been made, and its basis is "Blue Center" steel—an exclusive Roebling development. Its high resistance to abrasion, shock and fatigue spells long life . . . To this, Roebling *Preforming* brings the further advantages of new handling ease and improved performance . . . And the addition of I.W.R.C. assures top resistance to operating pressures and provides increased rope strength.

Roebling makes a wire rope of the right construction, grade and size for every type and make of rope-rigged equipment. Have your Roebling Field Man recommend the best rope for low-cost performance on each of your installations.

ROEBLING

A CENTURY OF CONFIDENCE

DISTRIBUTED BY
THE NATIONAL SUPPLY COMPANY
REPUBLIC SUPPLY COMPANY

FACTS YOU SHOULD KNOW . . . about

G-E 2-Way Radio

NARROW BAND vs. WIDE BAND

• Narrow band equipment (20 kc channels in the 25-50 mc band) is ALLOCATION INSURANCE. It is almost inevitable that future geographical assignment plans made by industry advisory groups will be drawn up on a 20 kc channel separation basis. Installation of 20 kc equipment NOW protects your system against interference from same-area stations 40 kc off your own frequency and from skip signals only 20 kc removed from your channel. It would be to your advantage to consider a change-over now.

Extended field and lab tests show:

1. There is no discernible difference in communication range between 20 kc and 40 kc systems.
2. Lower multiplication factor in 20 kc transmitters means substantial reduction of spurious radiations.
3. Signal-to-noise ratio differences in high signal level areas are insignificant.

• You'll find more true, high-selectivity General Electric 20 kc units in service than all other makes combined. And G. E. also manufactures high-performance units for expansion of present systems where continued operation on a 40 kc channel basis is desired.

Instant communication for wide-area operations is our specialty. There's a radio communication representative at the G-E office near you. Ask him for full details. Meanwhile, write for some interesting new literature on microwave equipment: General Electric Company, Section 890-21, Electronics Park, Syracuse, New York.

GET THIS BULLETIN—Bulletin X55-752 is important to every communications engineer. Write for your copy: *General Electric Company, Section 890-21, Electronics Park, Syracuse, New York.*

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Superior 6822

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Trinity 3417

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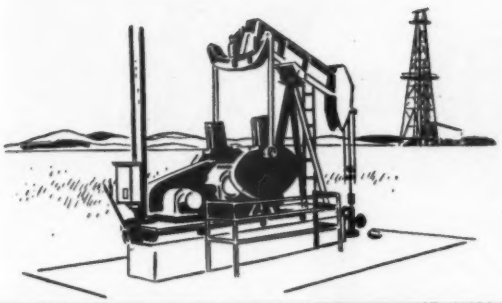
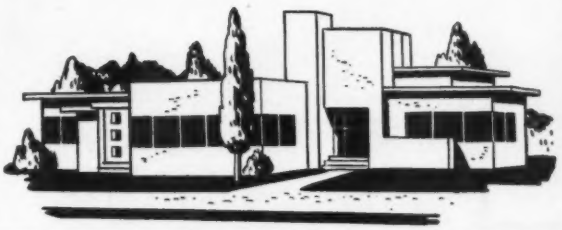
You can put your confidence in—

GENERAL ELECTRIC

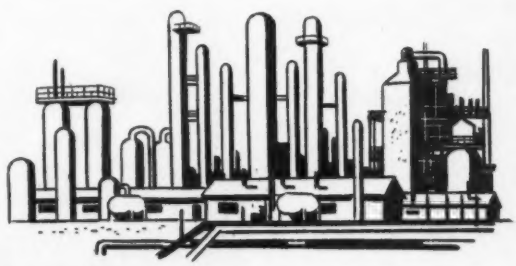
THROUGHOUT THE OIL INDUSTRY

the trend is to *Electric!*

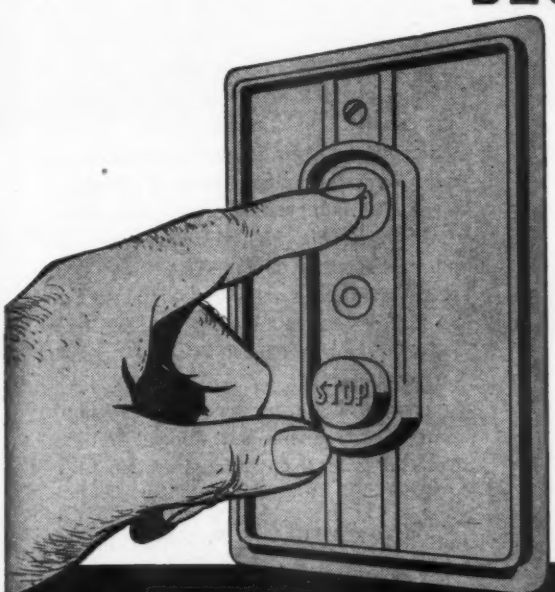




- In Production
- In Pipe Line Pumping
- In Refining



BECAUSE



YOU'LL SAVE 7 WAYS WITH ELECTRIC POWER

- Lowest initial capital investment
- Minimum operating, maintenance and labor costs
- Greatest flexibility with changing operating conditions
- Dependable, day and night, all-weather performance
- High salvage value of electric power equipment
- Maximum portability
- High safety factor

Houston Lighting & Power Company engineers will gladly discuss your requirements for field or refinery.

Houston Lighting and Power Company

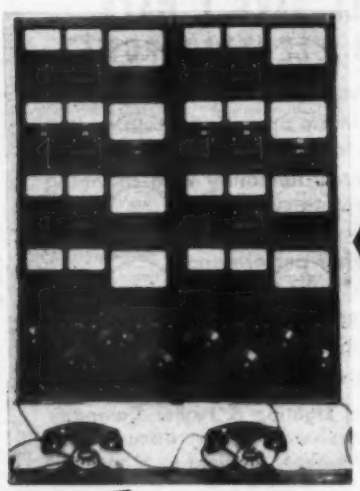
PRODUCERS OF LOW-COST ELECTRIC SERVICE

XUM

ELECTRONIC TANK GAUGING

Explosion proof design for high and low pressure tanks

Explosion proof, multi-tank, gives INSTANTANEOUS, *continuous gauge of selected tank*



Multi-tank gives simultaneous, continuous gauge of all tanks. High and low level alarms and pump or valve controls can be set to suit.

"VAREC" ELECTRONIC GAUGERS have been proved again and again in Pipeline Station and Terminal Service!

The increasing number of "Varec" Electronic Gauger installations testify to the benefits obtained from centralized gauging with proper equipment.

For example, one operator required that his laboratory maintain absolute control over products stored in all tanks and that his pump-house control the tanks being pumped. A panel of "VAREC" Figure No. 800 Receivers with high-low level alarms in the lab now permits his men to take gauge readings of any or all tanks simultaneously. If other duties require their attention, the alarm system instantly notifies them of dangerous levels. His pumpers can gauge any selected tank on the Fig. No. 813 Receiver in the pump house. Both laboratory and pump house receivers are connected to the same tank transmitters with a minimum amount of wiring to make this a practical and economical installation.

You too, can apply Electronic gauging to your oil movement and storage problems. Costs are lower than you might think.

Call in a "VAREC" representative today

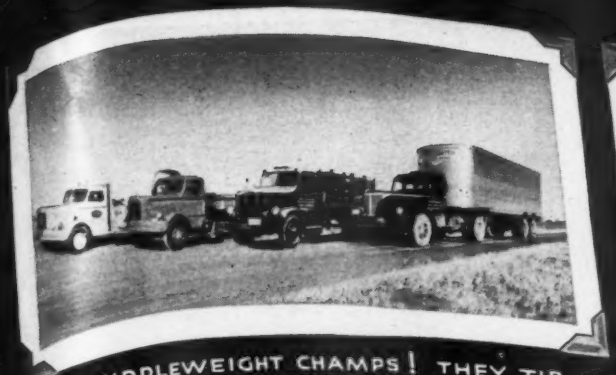
PROVED and APPROVED "Varec"

THE VAPOR RECOVERY SYSTEMS COMPANY

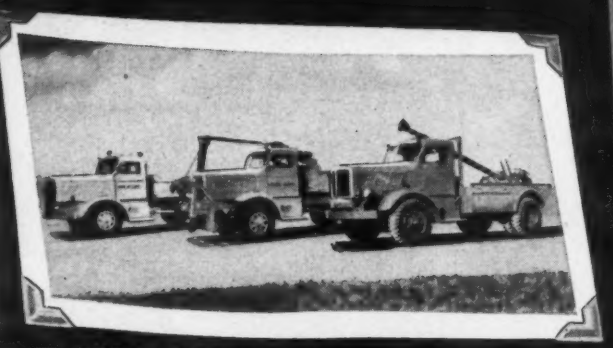
COMPTON, CALIFORNIA, U. S. A.

Cable Address: VAREC COMPANY USA (All Codes)

New York — Boston — Pittsburgh — Chicago — Detroit — St. Louis — Houston Tulsa — Casper, Wyo. — Provo, Utah — Los Angeles — San Francisco — Seattle



OUR MIDDLEWEIGHT CHAMPS! THEY TIP THE SCALES AT 17,000 TO 25,000 GVW... MODELS HR--HG--HA--HRC



THESE MEDIUM-HEAVIES WIN BLUE RIBBONS IN THE 28,000 TO 34,000 GVW CLASS. MODELS YU--ZU--SU

OUR BIGGEST 4X4 BRUTES WEIGH IN AT 40,000 TO 44,000 GVW MODELS M-7 AND M-10

INTRODUCING THE LD! OUR POPULAR NEW OFFSPRING--THE ONLY *TRUE* LIGHT-DUTY 4X4! A 14,500 GVW WONDER BOY

BIG 6X6 BRUISERS! 30,000 TO 60,000 GVW MODELS M6X6--H6X6 --MU6X6

Meet the whole family!

This line-up in our album covers the big FWD family of *basic* models. You should see the *other* pages... picture-after-picture of both highly specialized and conventional applications... plus photo-proof of economy, safety and spectacular performance... both on and off the highway. Put the *extra-traction* and *proper weight distribution* of this family of bread-winners to work for you, too! See your FWD distributor or write FWD.

THE FOUR-WHEEL-DRIVE AUTO CO. • Clintonville, Wisconsin

Canadian Factory: Kitchener, Ont.

World-Wide Sales and Service

FWD

America's Foremost Heavy-Duty Truck

another Owens-Corning FIRST!

NEW Parallel Reinforced Coromat Pipe Wrap ... 50% Stronger!

Lick Your Problems Aboveground and Below With the Wrap That's Better *NATURALLY!* Now breakage is practically impossible. The parallel reinforcing of glass is stronger weight-for-weight than most steels — and that means more miles per day for the dope man!

Look at the picture. The glass fibers are fine and there are more of them. This means even density, perfect penetration, no holidays.

Made of glass, Coromat is better *naturally*... has highest resistance to electrolysis and acids. It won't rot. It has highest impact resistance. Dimensionally stable, Coromat has no wicking action, won't take up moisture, won't sag underground.

Backed by science and experience, Coromat is doing a better job everywhere, and the new parallel reinforced Coromat makes the best still better. Why accept less? Get data and samples now!

We originated glass wraps.
We have the facilities.
Our research never ceases.
When better wraps are built, we will build them!

OWENS-CORNING
FIBERGLAS

COROMAT Pipe Wrap

**Fiberglas is the trade-mark (Reg. U. S. Pat. Off.) of Owens-Corning Fiberglas Corporation for a variety of products made of or with glass fibers. Coromat is the trade-mark of Owens-Corning Fiberglas Corporation.*

FREE! Write for booklet, "Corrosion Protection for Underground Pipe", and sample of Coromat. Owens-Corning Fiberglas Corporation, Dept. 54-14, Toledo 1, Ohio. Branches in principal cities.

FIBERGLAS IS IN YOUR LIFE...FOR GOOD!

XUM

Owens-Corning Fiberglas* Pipeline Outer Wrap Protects the Corrosion Protection

Better Naturally!

We introduced glass wraps. We have the greatest facilities. Our research never ceases. When better wraps are made, they'll be Fiberglas wraps!

OWENS-CORNING
FIBERGLAS

PIPELINE OUTER WRAP

*Fiberglas is the trade-mark (Reg. U. S. Pat. Off.) of Owens-Corning Fiberglas Corporation for a variety of products made of or with glass fibers.

Here is an outer wrap that settles the outer wrap problem without introducing new problems.

This pipeline outer wrap provides the protection of **tar-and-bitumen,** plus the benefits of a **strong,** organic **glass fabric body. Perfect bonding** is achieved through **controlled porosity,** which allows entrapped air to escape during application.

The **glass fabric base** of Fiberglas pipeline outer wrap has **no wicking action. It won't absorb moisture. It won't draw off the rich protective oils** of the coating or the tar-bitumen saturant. It **applies snugly around bends.** The glass fiber body is **practically unbreakable** under any stress ordinarily encountered in the field.

Fiberglas pipeline outer wrap is the product of the pioneers in glass wraps—and the leader still leads! Better get data and samples! Owens-Corning Fiberglas Corporation, Dept. 54-14, Toledo 1, Ohio. Branches in principal cities.

FIBERGLAS IS IN YOUR LIFE...FOR GOOD!

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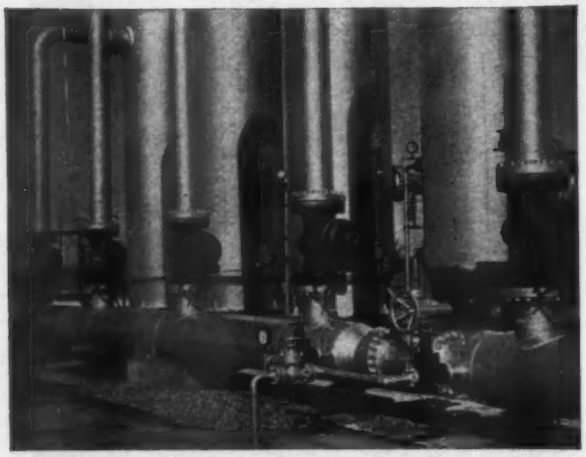
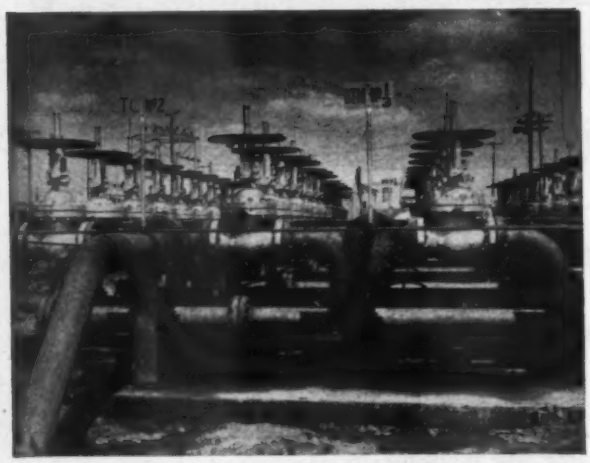
WALWORTH PIPE LINE VALVES...



Walworth 12-inch, steel, Lubricated Plug Valves on scrubbers in blower station yard of a southwestern pipe line company.



Walworth 8-inch, Series 600 Cast Steel, outside screw and yoke type, Pipe Line Gate Valves with stem protectors.

Walworth 26-inch, Series 600 Cast Steel, Pipe Line Valve with double handwheel operator in a South American pipe line.

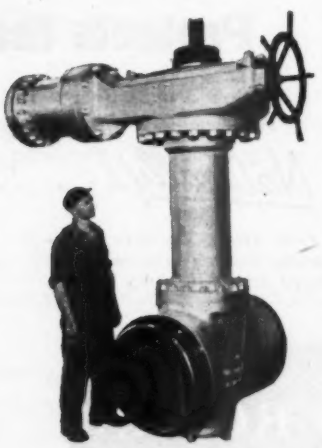
Walworth makes BOTH gate valves and lubricated plug valves for pipe line service

Walworth Pipe Line Valves are handling crude oil, fuel oil, gas, gasoline, and allied products in many of the most important pipe lines of the world. Their design is the result of years of experience in the production of valves to meet the particular requirements faced by the Oil and Gas Industry, in the distribution of its products through pipe lines.

Walworth Cast Steel Pipe Line Gate Valves and Cast Steel Horizontal Check Valves are accurately machined to close tolerances. They are produced for maximum cold working pressure, and have face-to-face and other dimensions in accordance with the current API standards. Discs of both Gate Valves and Check Valves open completely out of the passageway, allowing an unobstructed passage for scrapers or other tools.

Walworth Lubricated Plug Valves, because of the many advantages peculiar to the design of this type of valve, have gained wide acceptance in pipe line service, particularly on lines carrying natural or artificial gas and finished petroleum products.

Full information furnished upon request.



A Walworth 26 x 24-inch Lubricated Plug Valve for 960 pounds working pressure, with a high pressure cylinder for use in conjunction with automatic valve control. Built for natural gas pipe line service.

WALWORTH

valves and fittings

60 EAST 42nd STREET, NEW YORK 17, N. Y.

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

CP EQUIPMENT

for pipeline contractors

Fuel-thrifty Air Compressors. For pipeline construction, CP Portable Air Compressors of 60 to 500 c.f.m. are especially recommended. Sound design and rugged construction insure dependability in pipeline service. Also available are high-pressure models for pipeline testing.

There's a CP Sinker built for the job. In the complete CP line of Sinker Drills—ranging from the 28 lb. CP-22 to the 119 lb. CP-60N for the heaviest work—you'll find exactly the right model for any job. The CP-59 (55 lb. class) is widely used for general heavy-duty drilling.

CP Winches with catheads. CP Utility Winches—powered by air or gasoline motors—are available with a combination drum and cathead arrangement, which greatly increases the versatility of their operation.

Tampers speed trench work. CP Backfill Tampers—with easy control of speed and impact—assure firm and uniform tamping. Available in models to meet every tamping requirement.

Write for full information

CHICAGO PNEUMATIC TOOL COMPANY

General Offices: 8 East 44th Street, New York 17, N. Y.

PNEUMATIC TOOLS • AIR COMPRESSORS • ELECTRIC TOOLS • DIESEL ENGINES
ROCK DRILLS • HYDRAULIC TOOLS • VACUUM PUMPS • AVIATION ACCESSORIES

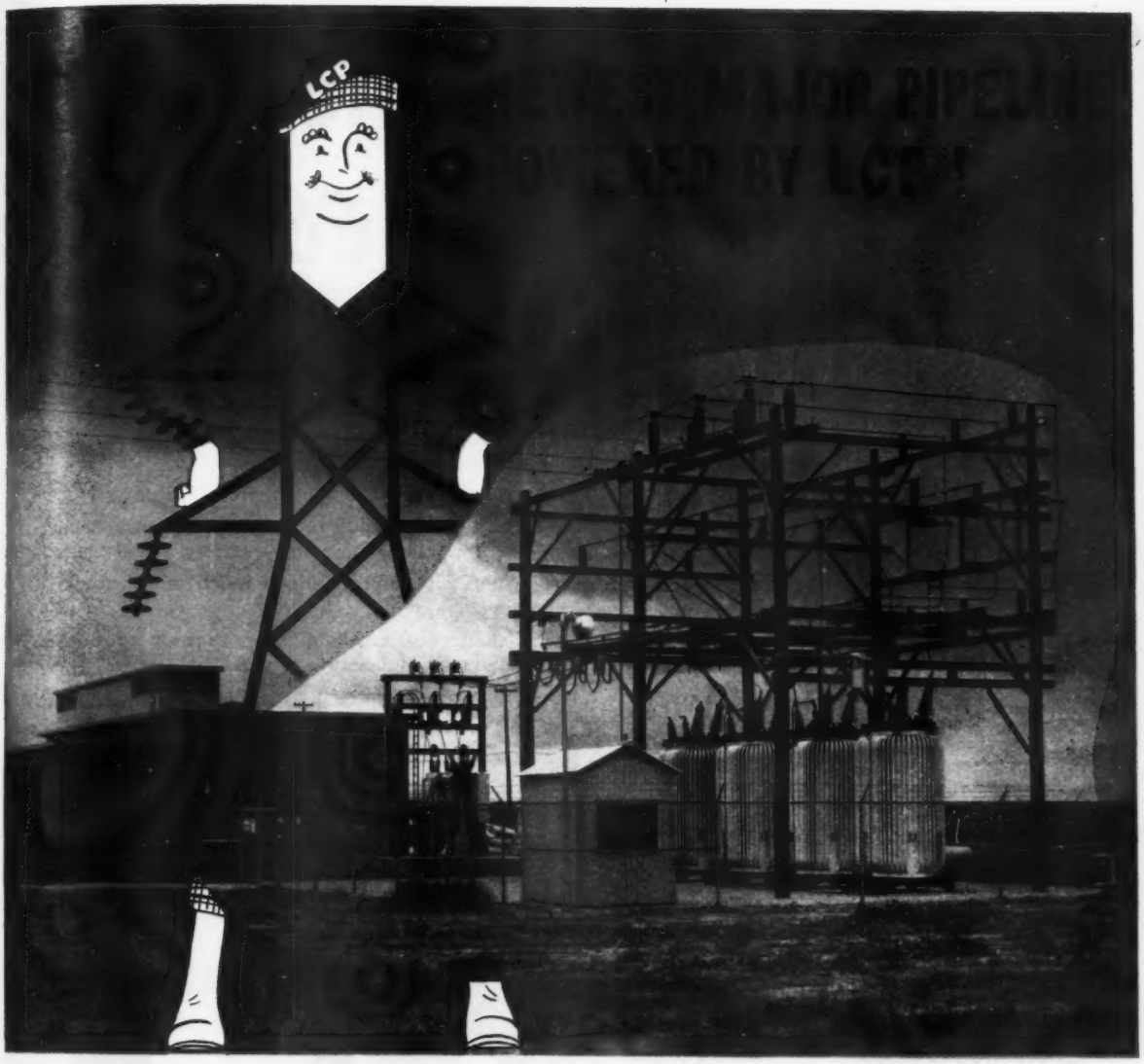
WHEATLAND PUTS THE *PRESSURE* ON

Wheatland's "pipe with the yearmark" is built to *take it*. That's why one of the most important steps in the Wheatland manufacturing process is the 1000 pound hydrostatic pressure test. Wheatland puts the pressure on *quality* at *every* stage in the manufacture of steel pipe in order to guarantee production of a product with *built-in* endurance.

-pipe with the yearmark!

WHEATLAND TUBE COMPANY

Bankers Securities Bldg., Juniper and Walnut Sts., Philadelphia 7, Pa.



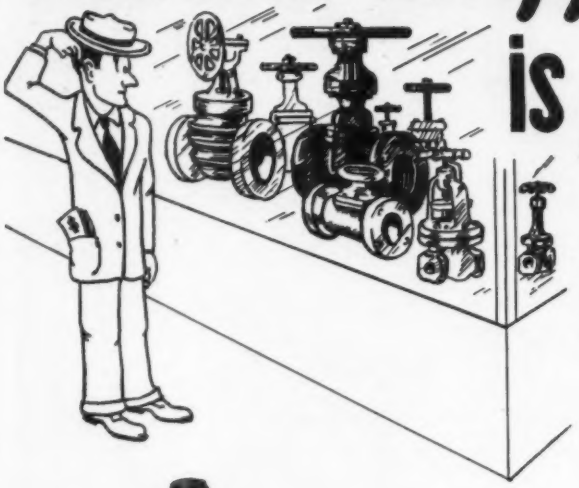
MORE and MORE PUMP STATIONS ARE POWERED BY *LCP EVERY DAY!

Pumping oil through the 1002-mile Basin-Ozark Pipe Line System is a "snap" for me! When it comes to pipeline operation, I have an impressive record! Check costs... low installation, operating, maintenance and labor costs! Check convenience... fewer repairs, easy portability, automatic controls! Check dependability... smooth, trouble-free operation. Call the Power Engineer of your Utility Electric Power Company—he has the figures to bear out my record!

*LOW COST POWER

PETROLEUM ELECTRIC POWER ASSOCIATION

"Window Shopping" for Valves is poor economy



Reading advertisements is like "window shopping"—it's a good way to see what's on the market. But don't let it influence you into buying your flow control equipment from different sources.

Because if you buy all your valves from one source you avoid these pitfalls:

Complications in stocking spare valve parts.

Difficulties that confront the maintenance department in making repairs on a variety of valves.

The necessity of carrying a much larger stock of repair parts.

The chances of installing valves that are not backed by adequate engineering service.

By offering the *only* COMPLETE line of valves available to Industry today, Powell makes this possible. And if you consult Powell Engineers and select the right valve to suit each individual service, your flow control problems are ended.

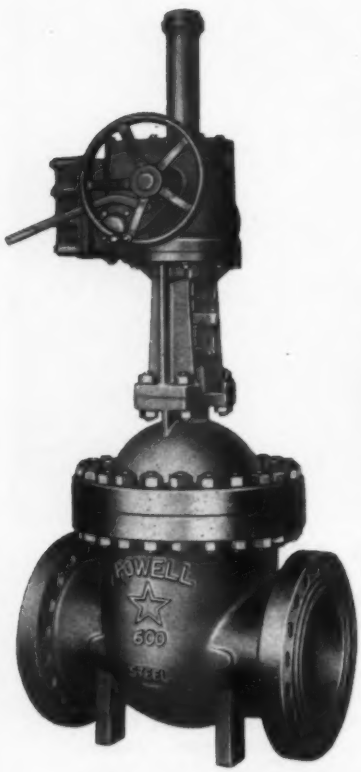


Fig. 6079 M.O.—Class 600-pound Cast Steel Gate Valve for Pipe Line Service. Has flanged ends and bolted flanged bonnet. Motor operated. Also available in Classes 150, 300, and 400 pounds.

Fig. 375—200-pound Bronze Gate Valve. Screwed ends, union bonnet, inside screw rising stem and renewable "Powellium" wear-resisting nickel-bronze disc.

Fig. 1561—Class 150-pound Cast Steel Swing Check Valve with flanged ends and bolted cap.

Fig. 1793—Large 125-pound Iron Body Bronze Mounted Gate Valve with flanged ends, bolted flanged yoke, outside screw rising stem and tapered solid wedge. Also available in All Iron.

The Complete Powell Line includes Globe, Angle, "Y", Gate, Check, Non-return, Relief and Flush Bottom Tank Valves in Bronze, Iron, Steel and a wide range of Corrosion-resistant metals and alloys.

Ask your nearest Distributor—or write direct

The WM. POWELL Co., 2525 Spring Grove Ave.
P. O. Box 106, Station B, Cincinnati 22, Ohio
DISTRIBUTORS AND STOCKS IN ALL PRINCIPAL CITIES

POWELL VALVES

XUM

Dependable Selectivity...

Efficient H_2S removal in the presence of CO_2

Dependable, low-cost removal of H_2S in the presence of large volumes of CO_2 is a primary advantage of the Shell Phosphate Process. All but harmless amounts of H_2S are removed while most of the CO_2 is left untouched.

Important too is the fact that the treating process has no harmful effect upon subsequent processing operations. The treating agent is inorganic . . . non-contaminating to hydrocarbons.

Low operating costs are the rule with the Shell Phosphate Process. Since a minimum of CO_2 is removed, steam regeneration of the treating solution costs less. Also, because the regenerated H_2S is in a relatively high concentration, the cost of conversion to solid sulphur or sulphuric acid is greatly reduced.

The Shell Phosphate Process is available to any operator under license from the Shell Development Company . . . together with experienced engineering service for its design, installation, and operation.

SHELL

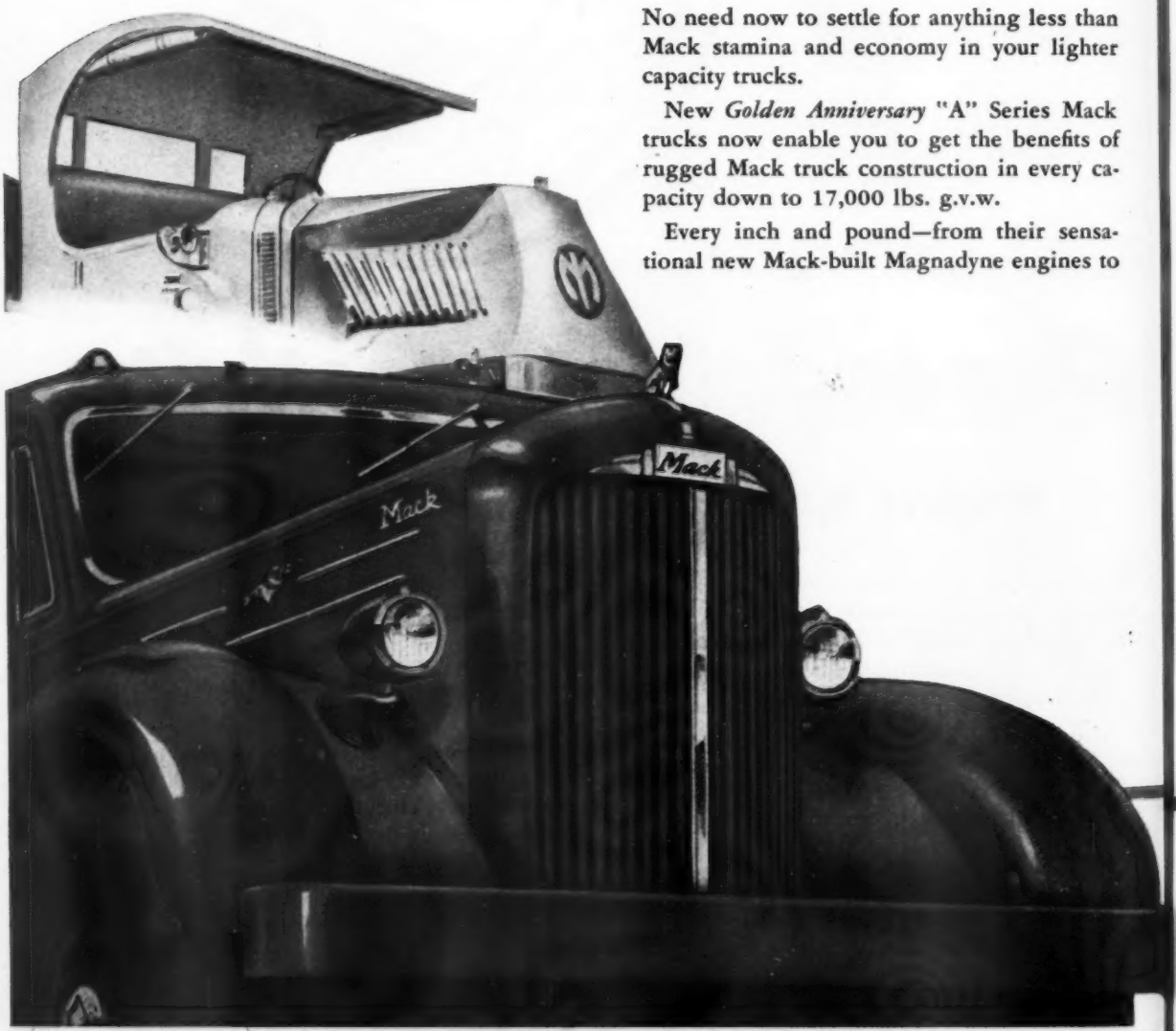
SHELL DEVELOPMENT COMPANY

50 West 50th Street, New York 20, N. Y.

XUM

NEW *Golden Anniversary*

Now! Money-Saving Mack before available in Popular



No need now to settle for anything less than Mack stamina and economy in your lighter capacity trucks.

New *Golden Anniversary* "A" Series Mack trucks now enable you to get the benefits of rugged Mack truck construction in every capacity down to 17,000 lbs. g.v.w.

Every inch and pound—from their sensational new Mack-built Magnadyne engines to

MACK TRUCKS

advantages never -Size trucks

their exclusive rubber Shock Insulated spring suspension—these new Macks are engineered in the same high quality Mack tradition as their famous forebears . . . built to handle their hauling jobs with all the enduring reliability and longer life which has marked Mack performance for half a century.

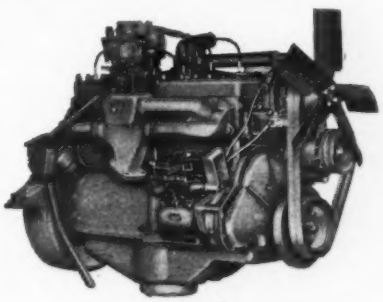
See these great new Macks at your nearest Mack branch or distributor. You'll find that for your lighter hauling jobs, they measure up in every respect to the standards you've grown to expect from dependable, long-wearing heavy-duty Macks.

BE PROFIT-WISE

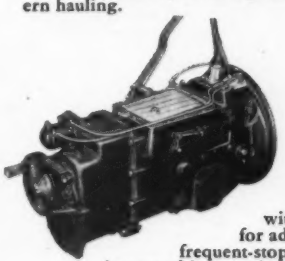
modernize with

outlast them all

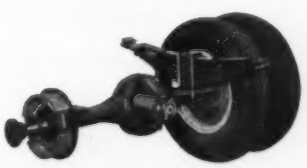
Mack Trucks, Inc., Empire State Bldg., New York 1, N.Y. Factories at Allentown, Pa.; Plainfield, N.J.; Long Island City, N.Y. Factory branches and distributors in all principal cities for service and parts. In Canada: Mack Trucks of Canada, Ltd.



Greater fuel economy . . . longer engine life . . . lower maintenance costs . . . sustained high performance. You get them all in the great new Magnadyne engine—a powerplant designed and built by Mack especially for modern hauling.



Prolonged Clutch Life with less need for adjustment in frequent-stop operations is assured by oversized clutches—one full size larger than customary on competitive makes of trucks.



Broad adaptability to diversified operating conditions is made possible by models which offer a choice of over-geared or direct drive type transmission, as well as axle selection and a range of gear ratios.

Frame stiffness and strength are assured by full-depth side-members braced by cross-members of Mack's box-girder design. Mack rubber Shock Insulators at spring-ends eliminate twisting strain, absorb vibration, require no lubrication or adjustment, last indefinitely.

8553

Why WORTH WELDED STEEL PIPE?

. . . because the same quality that established Worth as a leader in the manufacture of Steel Plate is found in Worth Welded Steel Pipe.

From the combining of chemical elements . . . through open hearth and rolling mills, the quality of the steel plate is rigidly controlled to assure unusual bending and welding qualities. A modern, well-equipped mill then forms the plate into pipe which is hydraulically expanded and hydrostatically tested to insure straightness, roundness and ability to meet the most rigid specifications.

Worth "Fully Deoxidized" Steel Pipe—easier to fit-up and lay-down because it is easier to bend and weld—is available in 40' lengths in 22", through 36" O.D. Deliveries are reasonably prompt. Write for details.

FLANGED AND DISHED HEADS • CARBON AND STAINLESS-CLAD STEEL PLATES

WORTH STEEL COMPANY · Claymont, Delaware

This Simple Compressor Meets the Complex Needs of a Changing Petroleum Industry

It's the Nash!

Here is a compressor presenting advantages found in no other device. Nash Compressors have only one moving part, rotating without metallic contact with the pump casing. No internal lubrication is required. Yet they produce 75 lbs. pressure in a single stage, with capacities to 6 million cu. ft. per day in a single structure.

There are no valves, gears, pistons, sliding vanes, or other complicated wearing parts in a Nash. Compression is secured by an entirely different principle of operation. Because of this, gas pumping problems difficult with ordinary pumps are often easily handled by the Nash. For example, Nash Pumps are standard equipment in the Synthetic Rubber Industry, where they have met the needs of new and difficult processes.

Nash Compressors are compact and save space. They run without vibration, and compression is without pulsation. They maintain original performance over long periods. Service is assured by a nationwide net-work of Engineering Service offices. Instructive bulletin shows how they operate. Write for it.

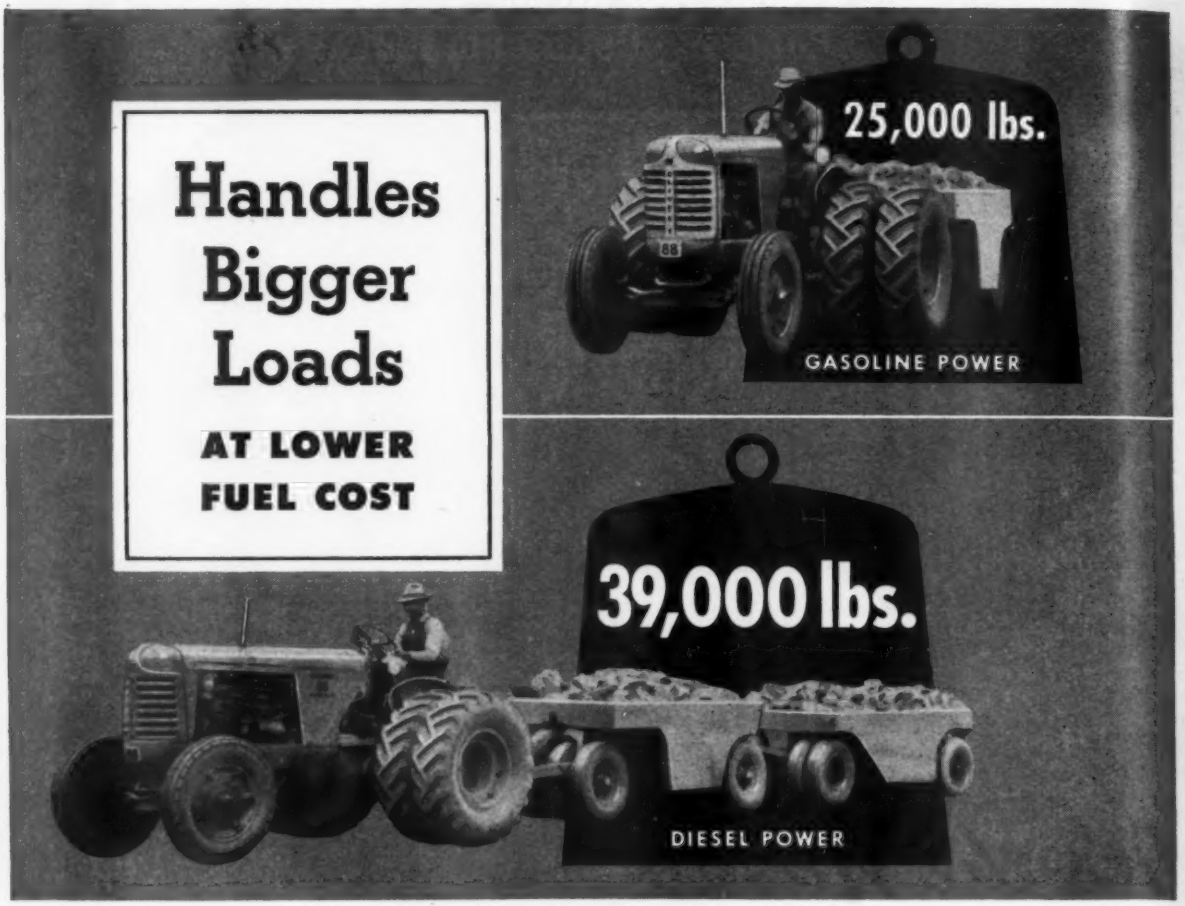
- One moving part.
- No internal wearing parts.
- No valves, pistons, or sliding vanes.
- No internal lubrication.
- Low maintenance.
- Slugs of liquid entering pump do no harm.
- Non-pulsating pressure.
- Saves floor space.
- 75 pounds in a single stage.

NASH ENGINEERING COMPANY

273 WILSON, SO. NORWALK, CONN.

XUM

OLIVER DIESEL POWER



What better proof could you ask of the *economy* you get with the new Oliver "88" Diesel Wheel Tractor? On this job an "88" Diesel is handling *two* rubber-tired compaction rollers vs. a gasoline powered tractor of equivalent size pulling *one* roller. The owner reports a fuel cost saving of 50% even though the Diesel model was pulling a load of 39,000 lbs. vs. the Gasoline model pulling a load of 25,000 lbs.

The new Oliver "88" is a natural for industrial wheel tractor operations. It's remarkably easy to start . . . requires no starting preparations. Overall efficiency is high due to superior air and fuel mixture. Efficient burning of fuel and air assures exceptional fuel savings. Prolonged piston head pressure increases lugging ability under heavy loads.

You'll find it will pay dividends in increased load handling ability . . . lower operating costs to investigate the new Oliver "88" Diesel Industrial Wheel Tractor. Your Oliver Industrial Distributor will give you the complete story.

THE OLIVER CORPORATION

Industrial Division: 19300 Euclid Avenue, Cleveland 17, Ohio

A complete line of Industrial Wheel and Crawler Tractors

WHEN TESCO CASTINGS REPLACED A WELDMENT,

THE MANUFACTURER REDUCED FIRST COST,

CUT MACHINE TIME 50%,
INCREASED BEARING
SURFACE 50%

THIS IS THE WELDMENT

THIS IS THE STEEL CASTING

The story of why this manufacturer switched from weldments to steel castings for his pipe line cradles has a moral that can apply to your products, too. Study the facts, at right, of the benefits to the manufacturer from his switch to steel castings. Conversion of some of your products to steel castings may result in equal if not greater advantages. At Tesco there is every modern facility in tools and craftsmanship to produce the very highest quality steel castings for every industrial need.

So before you design a new product or redesign an old one, let the Tesco product engineer help you reduce costs and get into production sooner. Let us show you how Tesco Steel Castings can help you produce stronger, better appearing products.

HERE ARE THE *FACTS*

The following advantages resulted when the manufacturer switched from weldments to steel castings:

1. The finished cast wheel weighed 90 lbs. as compared to 140 lbs. for the finished welded wheel . . . a saving of 50 lbs. per wheel.
2. Cost of the finished cast wheel was less than that of the materials needed to make a fabricated wheel and hub.
3. Bearing surface on the rims of the wheel was increased 50%.
4. The length of the three axles and housing was reduced 4"; resulting in other material savings.
5. Castings eliminated all preliminary machining and fabrication on the wheel.
6. Finished product appearance was [illegible]

TEXAS ELECTRIC STEEL CASTING CO.

GOOD CASTINGS — TESCO (CARBON AND ALLOY STEEL) — HOUSTON, TEXAS

XUM

FULL VIEW AHEAD MEANS FULL SPEED AHEAD

Absence of superstructures and mounting of hydraulic cylinders well to the rear enable the operator to see exactly what the blade is doing.

DIGGING slush pits . . . building dikes . . . backfilling pipe trench . . . whatever the oil field job, your operator can punch out more yardage with a full-vision Bucyrus-Erie Bullgrader. Hydraulic cylinders and rocker arms are mounted low so there's no superstructure to obstruct the view and slow up operation.

And there's performance to match this rig's top notch visibility! Designed specifically for International Crawler tractors, the Bucyrus-Erie Bullgrader is perfectly balanced to the tractor for full tractive effort. Power is concentrated at the blade, and the blade is scientifically curved to roll dirt forward smoothly and easily.

Get the full story on Bucyrus-Erie hydraulic and cable-controlled Bullgraders. Ask your International Industrial Tractor distributor to show you the quick angle and tilt feature, the simplified single lever control, and the overall long life construction of this time- and money-saving unit.

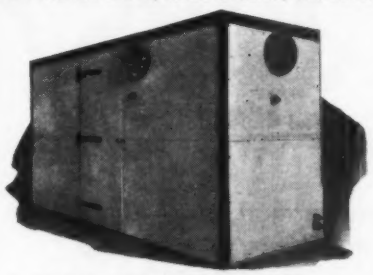
196T50

SOUTH MILWAUKEE BUCYRUS ERIE WISCONSIN

Here's Why KAYLO LAMINATED PANELS *Assure* FIRE-SAFE WALLS

...Resist IMPACT... HEAT LOSS... ROT... WATER DAMAGE

IN ONE OPERATION, 32 square feet of fire-safe wall goes into place. Kaylo Laminated Panels, with cement-asbestos facing, are only two inches thick and lightweight, yet they have better insulating value than 16″ of concrete. Panels can be sawed, nailed or bored, with standard tools.



In this typical installation, Kaylo Laminated Panels (with cement-asbestos facing) are used on a valve house.

See our CATALOG in WEEKS FILE

The unique feature of Kaylo Laminated Panels is the Kaylo core, a remarkable new hydrous calcium silicate (not glass). It is the basic reason why Kaylo Laminated Panels offer so many important advantages to the oil industry.

This new type of inorganic core material has a high percentage of microscopic voids, giving it exceptional resistance to heat passage. The incombustible Kaylo core is securely bonded to facings of cement-asbestos or metal with a waterproof adhesive. Installed with proper joint systems, the Kaylo Laminated Panels meet A.S.T.M. one-hour fire standards.

Sandwich construction plus the strong Kaylo core gives Kaylo Laminated Panels exceedingly high strength, dimensional stability and resistance to impact. The inorganic Kaylo core is rot-proof, vermin-proof and insoluble in water.

Kaylo Laminated Panels provide better curtain-walls or interior partitions with reduced building load and easier erection for nearly every type of building. Investigate now.

A VARIETY OF FACINGS ARE AVAILABLE on Kaylo Laminated Panels, including: cement-asbestos, wood veneer, and metals.

KAYLO®
LAMINATED PANELS

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KAYLO DIVISION • TOLEDO 1, OHIO
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Kaylo Division, Dept. N-84, Toledo 1, Ohio

Gentlemen: Please send me literature on Kaylo Laminated Panels

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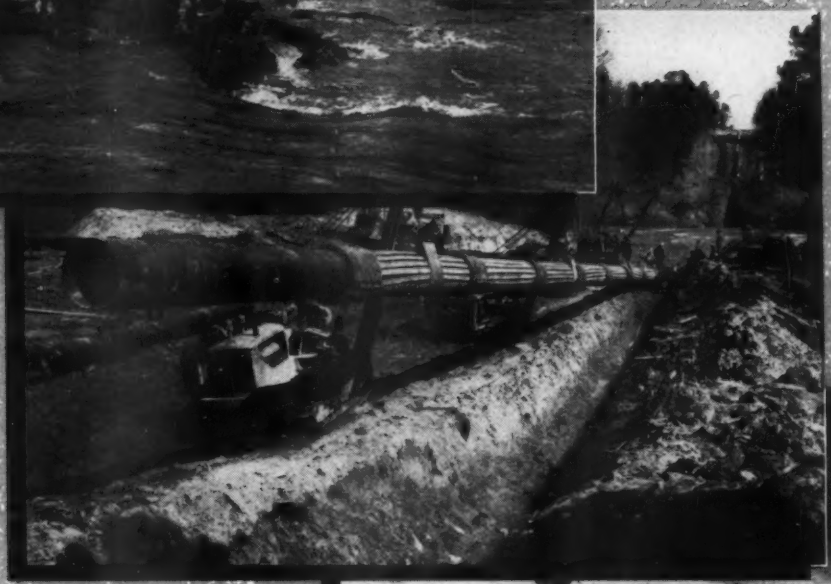
J&L STEEL WIRE ROPE handles TOUGH PIPE LINE JOBS!

You pipe line construction men lead rugged lives—deep mud, steep grades, heavy loads. The equipment you choose has got to stand up!

J&L Wire Rope is built with a thorough understanding—and appreciation—of your problems. Bronz-Lube protects the rope with a metal-lubricant bearing that can't be washed off. CenterFit design permits faster operating speeds—saving time and money. The close manufacturing tolerances of J&L Precisionbilt Wire Rope assures safety and uniformity.

This quality product—built to handle tough pipe line jobs—is readily available. Your nearby Jones & Laughlin Supply store stocks all popular sizes and types. Special purpose ropes can be obtained promptly from warehouse stocks. For convenience and service always buy thru your nearby Jones & Laughlin Supply store.



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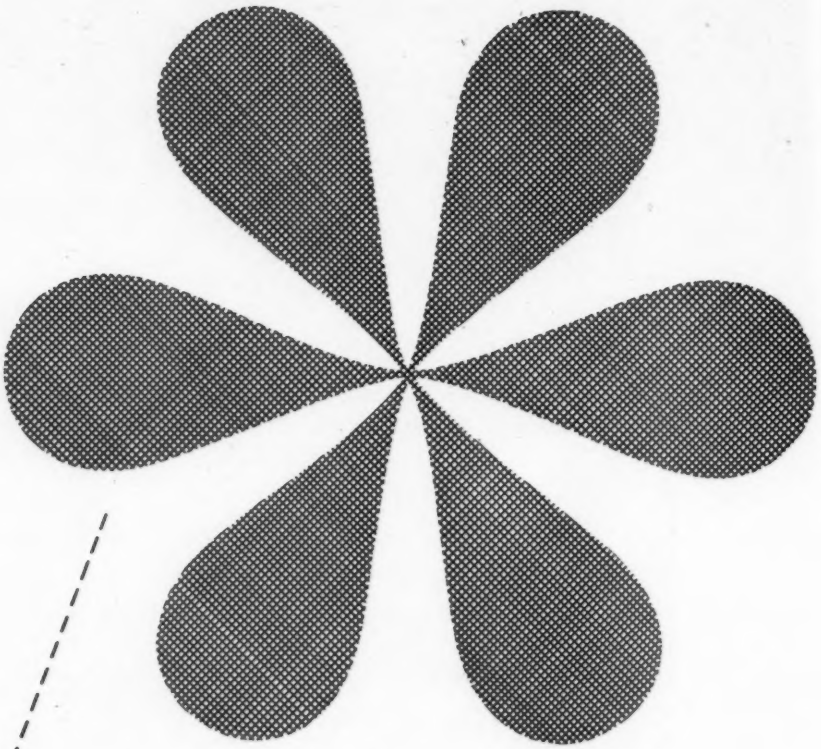


Footnote that speaks volumes

Here's one time when an asterisk refers to a really *important* footnote.

For the pipe dimensions listed below provide evidence that Kaiser Steel can meet practically every transmission pipe requirement of the petroleum, gas and water industries in the Western two-thirds of the nation!

Kaiser Steel pipe is manufactured to latest API and ASTM specifications—in diameters from ½ inch to 30 inches, and in lengths up to 40 feet. Shipping points are Fontana and Napa, Calif.

It's good business to do business with

Kaiser Steel

*** KAISER STEEL PIPE SPECIFICATIONS • All pipe manufactured to latest A.S.T.M. and A.P.I. specifications**

Type	Diameter	Length	Wall Thickness	Shipping Point
Continuous Weld—Threaded and Coupled	½" to 4" nominal I.D.	Uniform 21'	Standard	Fontana, Calif.
Continuous Weld—Plain End	2⅜" to 4½" O.D.	Up to 40'	Standard	Fontana, Calif.
Electric Resistance and Fusion Weld—Plain End	8⅝" to 22" O.D.	Up to 40'	.188" to .500"	Napa, Calif.—Basalt-Kaiser
Electric Resistance Weld—Plain End	5⅛" to 12¾" O.D.	Up to 55'	.188" to .400"	Fontana, Calif.
Electric Fusion Weld—Expanded—Plain End	24" to 30" O.D.	Up to 40'	.188" to .500"	Napa, Calif.—Basalt-Kaiser

Prompt, dependable delivery at competitive prices • KAISER STEEL CORPORATION Los Angeles, Oakland, Seattle, Portland, Houston, Tulsa, New York

Precision STUD BOLTS

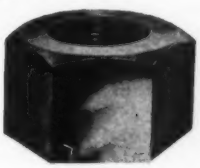
MANUFACTURED IN HOUSTON TO YOUR SPECIFICATIONS

ALLOY STEEL

SAE 4140—CHROME MOLY HEAT TREATED TO ASTM SPECIFICATIONS
A-193, GRADE B7—EACH STUD STENCILLED. - - - - - - - - - - - - N4 B7

CHROME MOLY VANADIUM HEAT TREATED TO ASTM SPECIFICATIONS
A-193, GRADE B14—EACH STUD STENCILLED. - - - - - - - - - - - - NB 14

HEXAGON NUTS



AMERICAN STANDARD HEAVY SERIES — COLD PUNCHED
SEMI-FINISHED ASTM A-194—CLASS 2—ASTM A-194
—CLASS 2 H.
THREADED-COARSE THREAD—8 PITCH, 12 PITCH AND WHITWORTH STANDARD.

STAINLESS STEEL

TYPES 303, 304, 316 AND 347 — BAR AND NUTS IN STOCK.
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BRASS AND MONEL

STUDS AND NUTS
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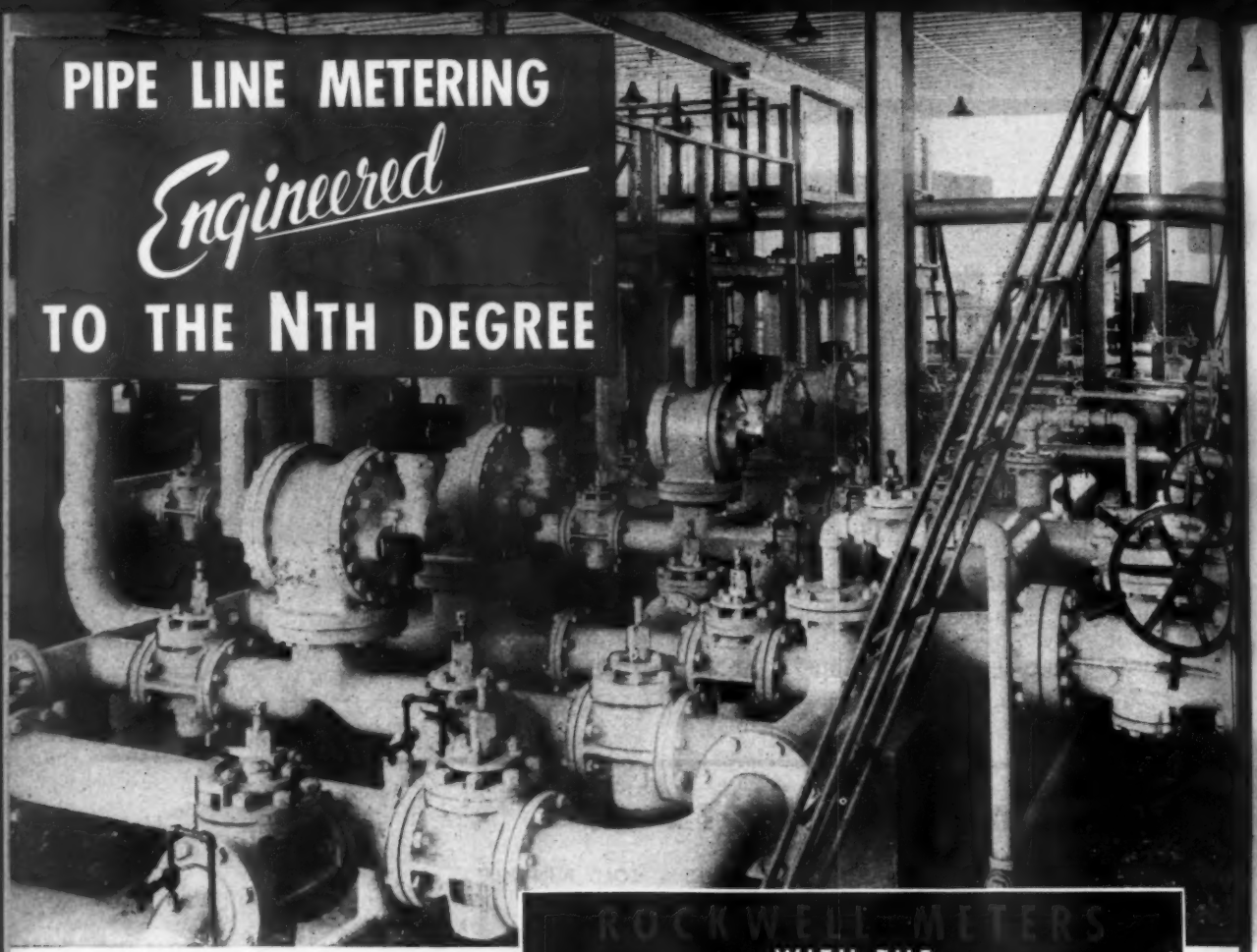
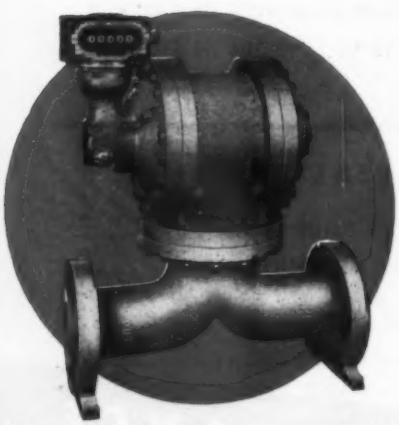
PIPE LINE METERING *Engineered* TO THE NTH DEGREE



Meter bank on Plantation line. Model 6 PL Rotocycles with straight reading registers and temperature compensators are used.



Model 6 PL Rotocycle with large straight reading re-set register—capacity 1150 barrels per hour. Three smaller sizes available. Ticket printers and other type registers optional.

ROCKWELL METERS

WITH THE

ROTOCYCLE

PRINCIPLE

COUNT OUT THE BARRELS AS THEY ROLL THROUGH THE LINE

The battery of Rockwell meters pictured is typical of hundreds of installations on major pipe lines throughout the country. Here is measurement engineering at its finest. The battery type installation assures stand-by equipment available for maintenance, proving and shutdowns. The size and number of meters has been carefully calculated in relation to full line capacity. Manifolding is flexible. All lines are under the quick, positive control of Nordstrom valves. Want the finest pipe line meters and the all-important measurement engineered installations that go with them? Then get in touch with our nearest District Office.

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Whatever your activity or interest in the oil industry in Oklahoma and the great Mid-Continent Area, National Bank of Tulsa has the banking facilities, the resources and complete services to fill your banking needs. A real pioneer in the specialized field of oil industry financing, NBT has grown in practical knowledge of oil operations and their banking requirements. You are cordially invited to make use of the complete services of this bank.

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R-S valvEvents

• EXCERPTS FROM THE R-S BOOK OF EXPERIENCE •

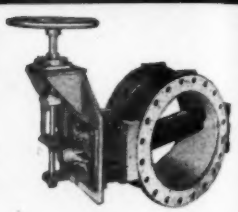
R-S FLOAT VALVE for Sewage Service

The R-S Heavy Duty Direct Action Float Valve controls the water level in a wet well of a sewage treatment plant at Quakertown, Pennsylvania. Illustration shows valve approximately 25% open. At the high level, practically drip tight shut off is obtained with metal-to-metal seat. The adjustable float connection keeps the float away from the area of turbulence.

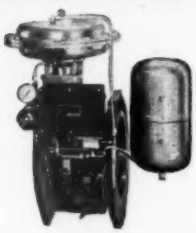
R-S Valves are used in air, gas, liquid, steam and semi-solid service for the shut off and regulation of volume and pressure, pressure relief, liquid level control, back pressure, water hammer, steam hammer, constant differential pressure, output control of pumps, fans, engines, turbines and automatic combustion. Suitable for service in the temperature range from minus 300°F to plus 2000°F. 2 to 2500 psig.

Specify R-S Valves for simplified control and shut off. Consult with your local R-S Valve Engineers or write direct.

R-S PRODUCTS CORPORATION
Wayne Junction • Philadelphia 44, Pa.



No. 700—20-inch 30-pound Cast Iron Valve with rubber seat, Type B-8934, for positive 100% shut-off. Heavy duty handwheel control with threaded reach rod. Type B-9469.



No. 781—Fourteen-inch Heavy Duty Cast Iron Valve with 125-pound American Standard flanges and drilling. Mounting bracket, crank arm, reach rod and linkage together with springless diaphragm top including positioner, gauge and an auxiliary tank as an integral part of the unit. Should all air fail, pressure in the tank will stroke the valve. Note the bronze bushings in bracket through which the air motor shaft passes.

No. 780—Eight-inch Off Center Valve for control of 15 psig saturated steam with 1 psi drop. Series 15, 150 - pound American Standard raised face flanges. Double crank arm with adjustable weights for accurate setting. Cylinder is not an actuator but simply a dash pot. Note 2-inch flanged outlet for overload relief.

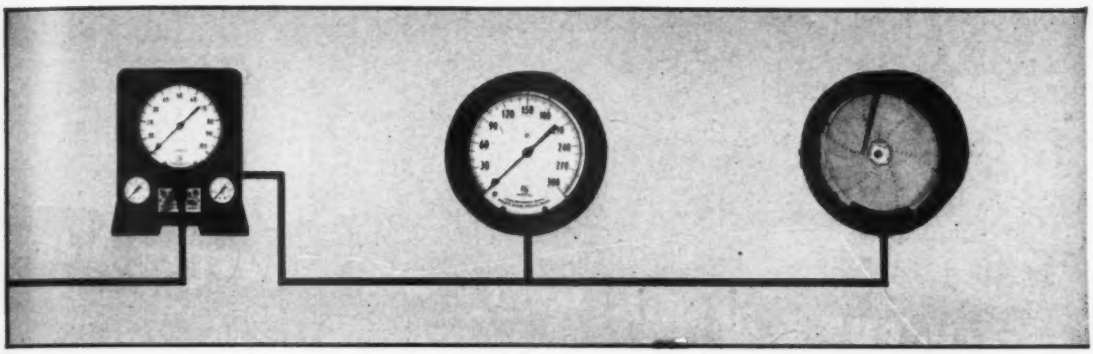
No. 782—Heavy Duty Wafer Type Valve, rubber seated, 5° angle seated vane with enclosed gear reduction drive.

Note that there is plenty of room to easily remove the gland and repack the stuffing box.

ASHCROFT and MICROSEN TRANSMISSION SYSTEMS

Score New Advance in the Field of Remote Indication

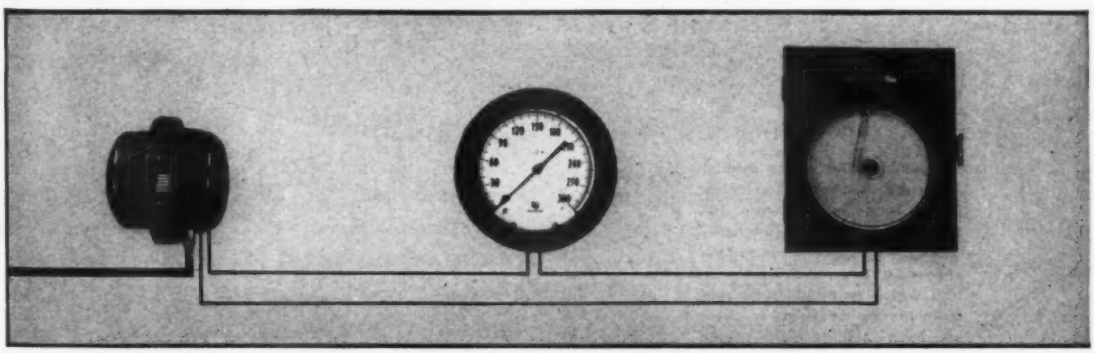
ASHCROFT PNEUMATIC AND MICROSEN ELECTRIC PRESSURE AND TEMPERATURE TRANSMISSION SYSTEMS COMBINE . . . SIMPLICITY, EASE OF INSTALLATION AND MAINTENANCE . . . LOW COST . . . AND HIGH OVERALL ACCURACY



ASHCROFT PNEUMATIC PRESSURE TRANSMISSION SYSTEMS

Particularly suitable where it is desired to avoid expensive, high-pressure piping or to confine inflammable, hazardous or corrosive liquids and gases close to their source. Pressure indications are transmitted by means of low pressure air over distances up to 1000 feet. Installation costs, leakage and maintenance problems, inherent with high pressure lines, are eliminated. These systems measure pressures up to 50,000 psi, including compound or straight vacuum ranges. There is an extensive selection of Bourdon tube materials and protective devices for all conditions of service.

Temperature Transmission—In addition to pressure measurement, the Ashcroft system can be used to measure temperature in applications where a thermostatic element would be more applicable than thermocouple actuation. Information about these systems available upon request.



MICROSEN ELECTRIC AND ELECTRO-PNEUMATIC TRANSMISSION SYSTEMS . . . PRESSURE OR TEMPERATURE

These systems . . . the Microsen Electric Pressure, the Microsen Electric Temperature and the Microsen Electro-Pneumatic Temperature . . . are designed to provide a wide range of remote pressure or temperature indication.

Microsen Electric Pressure Transmission Systems (illustrated above), are ideal wherever process pressures should be remotely indicated over distances of more than 1,000 feet, where an instantaneous response is desired for operational control, or where electrical instrumentation predominates.

Microsen Electric Temperature Transmission Systems transmit temperature indications wherever process temperatures should be indicated at one or more points some distance from the temperature source.

Microsen Electro-Pneumatic Temperature Transmission Systems provide the most accurate, easily maintained means of converting electrical temperature indications at a remote point into low pressure, pneumatic signals for temperature indicating, recording and control.

THE VERSATILITY OF MICROSEN TRANSMITTERS

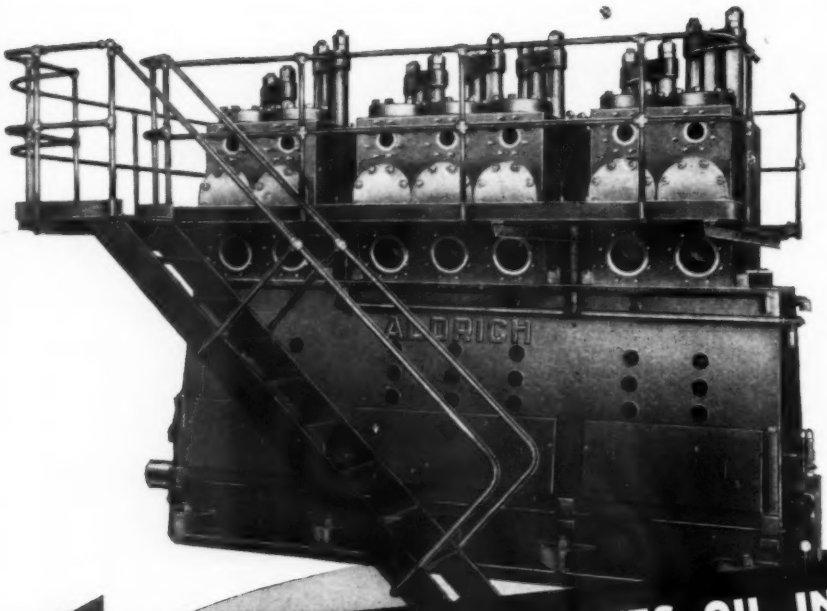
Beyond the transmission of pressures and temperatures, these instruments can be used for transmitting, amplifying or relaying a wide variety of electrical measurements. Typical fields of application available upon request.

A PRODUCT OF

MANNING, MAXWELL & MOORE, INC.

STRATFORD, CONNECTICUT

Makers of 'Ashcroft' Gauges, 'Hancock' Valves, 'Consolidated' Safety and Relief Valves, 'American' Industrial and 'Microsen' Electrical Instruments. Builders of 'Shaw-Box' Cranes, 'Budgit' and 'Load Lifter' Hoists and other lifting specialties.



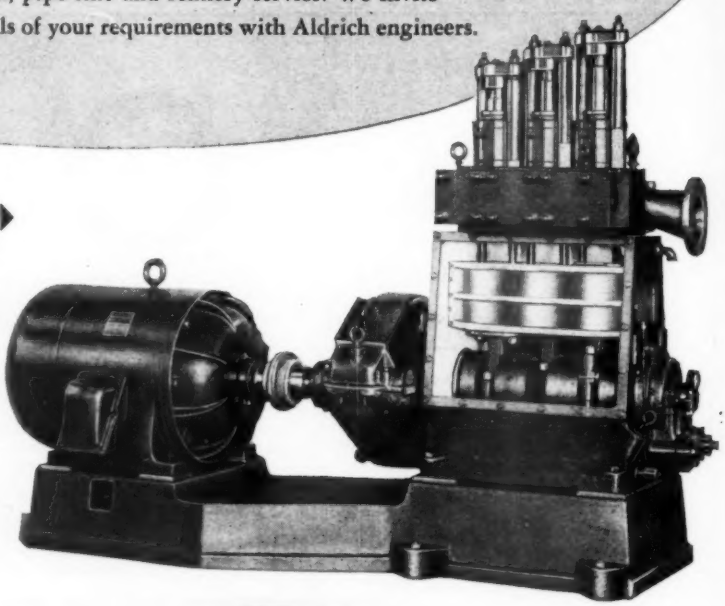
This 8½" stroke, 1900 hp Inverted Septuplex Pump was made for crude oil pipe line service and is designed for direct coupling to engine, motor or speed reducer. Illustration shows pump without suction and discharge manifolds. Request Data Sheet 67.

ALDRICH PUMP DESIGN MEETS OIL INDUSTRY NEEDS

Large or small . . . standard or special units . . . whatever your medium or high pressure pumping requirements may be — Aldrich designers, engineers and manufacturers can meet your needs! Here at Aldrich we are constantly developing and building new pumps to give improved, dependable performance in petroleum, pipe line and refinery service. We invite you to check the details of your requirements with Aldrich engineers.

A new addition to the Aldrich line—the 5" Stroke Direct Flow Pump Series ranges from 100 to 275 hp. The fluid-end has a through-flow, close clearance design and a sectionalized construction which features exceptional maintenance economies. Drive can be by electric motor, steam engine, turbine or internal combustion engine. Request Data Sheet 64.

Aldrich patented "KOSMOS" Porcelain Plungers are famous for saving money. They increase plunger and packing life, reduce down-time, resist corrosion, decrease friction and save power. Request Data Sheet 57-2.



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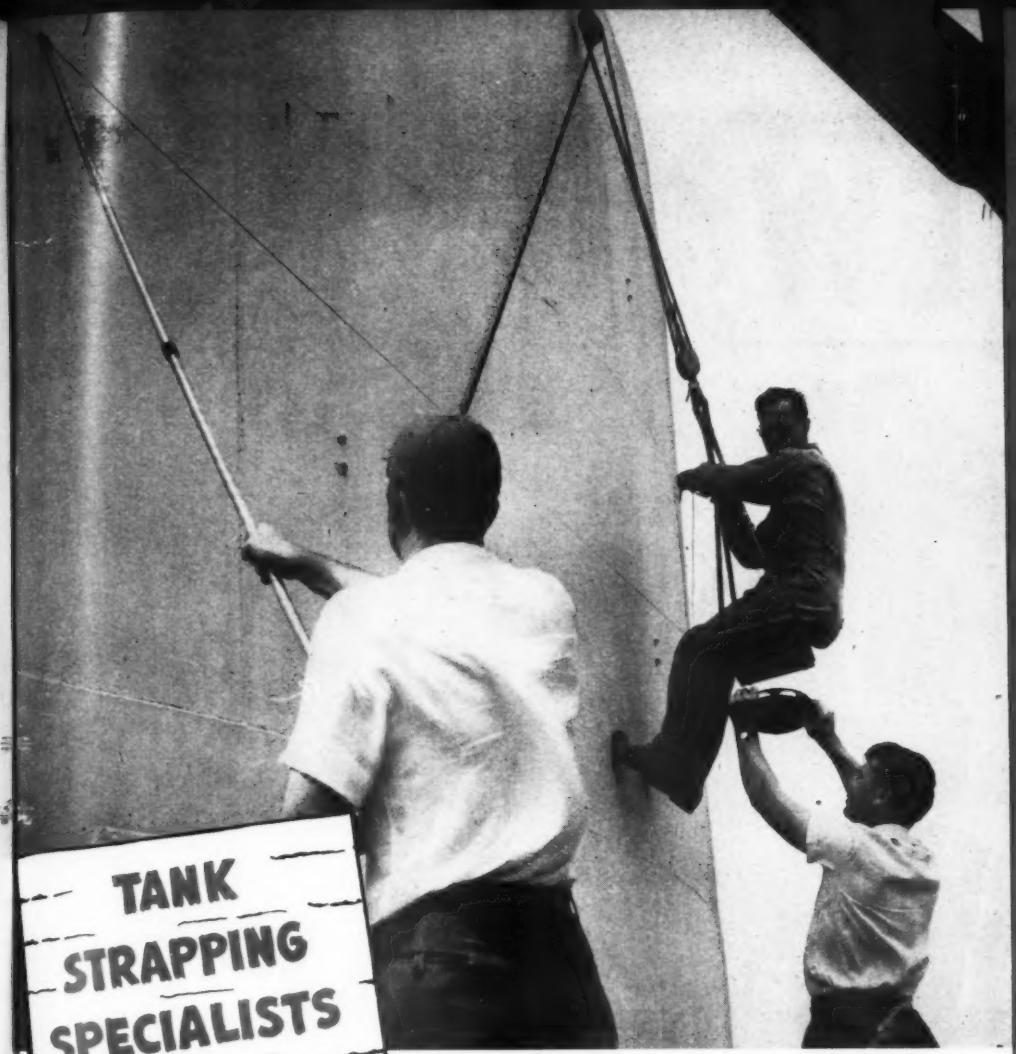
All Aldrich Pumps Have **STAYING POWER**



TANK STRAPPING SPECIALISTS AT WORK

Both buyer and seller of petroleum products benefit when Chas. Martin & Company tank strapping specialists are on the job. Long before the turn of the century . . . in fact, 75 years ago . . . representatives of Chas. Martin & Company started building a reputation for dependable petroleum inspection. During that span of years, Chas. Martin tank strapping specialists have strapped tanks in nearly all Gulf Coast refineries, plus thousands of others throughout the world. We invite inquiries to any of the strategically located Chas. Martin & Company offices . . . located to provide the best in petroleum inspection and tank calibration.

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Corpus Christi, Texas
Brownsville, Texas
Helena, Ark.
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San Luis Obispo, Calif.
San Francisco, Calif.
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NEW

SERIES 12100*

FORGED STEEL

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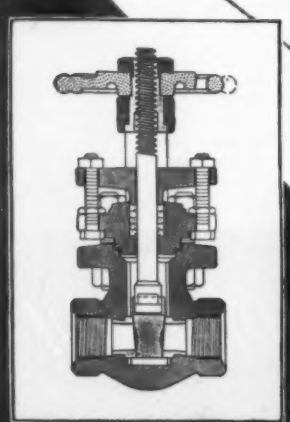
BOLTED BONNET
BOLTED GLAND

150-800 POUND

GATE VALVES

SIZES 1/4" to 2"



*Series 12100

CARBON STEEL | 800 Pounds @ 750 F.
1500 Pounds Cold Non-Shock

For 150-800 pounds service • Round Bolted Bonnet • Bolted Gland • Gasket or Ground Joint • Outside Screw and Yoke • Renewable Seat Rings • Solid Wedge — Slotted Type • Rising Stem 11½-13% Chrome Stainless Steel Trimmings • Sizes 1/4" to 2" inclusive.

HENRY VOGT MACHINE CO. *Louisville 10, Ky.*

BRANCH OFFICES: NEW YORK • PHILADELPHIA • CLEVELAND • CHICAGO • ST. LOUIS • DALLAS

Built to Cut Maintenance

EASIER MAINTENANCE PROCEDURES and lower maintenance costs are important features of this brand new line of large motors. One man can perform all routine maintenance procedures, including opening up the motor for cleaning. Bearing surfaces are not exposed to abrasive grit and dirt during cleaning operations.

The appearance of this new line of large motors reflects the advanced design and fine workmanship that goes into their manufacture.

A well-braced, sturdy fabricated steel frame with cast-iron end brackets rigidly support and protect working parts. Ventilating openings are large to provide adequate cooling air at low velocities with resultant low sound level.

Wide Range of Sizes

These new design Allis-Chalmers drip-proof and splash-proof squirrel-cage induction motors are built in sizes from 60 hp at 300 rpm to 1500 hp at 1800 rpm. Ask your Allis-Chalmers representative to show you the details of this exceptional new motor or write for Bulletin 05B6112.

How's This for Accessibility

One man can remove the end brackets and air baffles and reach right inside motor with his vacuum cleaner or air hose. Bearing remains sealed against abrasive dirt throughout the cleaning operation.

Large air discharge openings with removable louvers allow plenty of room to get in with an electric drill for doweling and bolting the motor to the base. Plenty of room to reach up back of the stator core for cleaning.

A-3179

ALLIS-CHALMERS, 1059A SO. 70 ST.
MILWAUKEE, WIS.

ALLIS-CHALMERS

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WORLD'S LARGEST GAS PIPELINE SYSTEM SPECIFIES W-K-M VALVES

BATON ROUGE

HOUSTON

BROWNSVILLE

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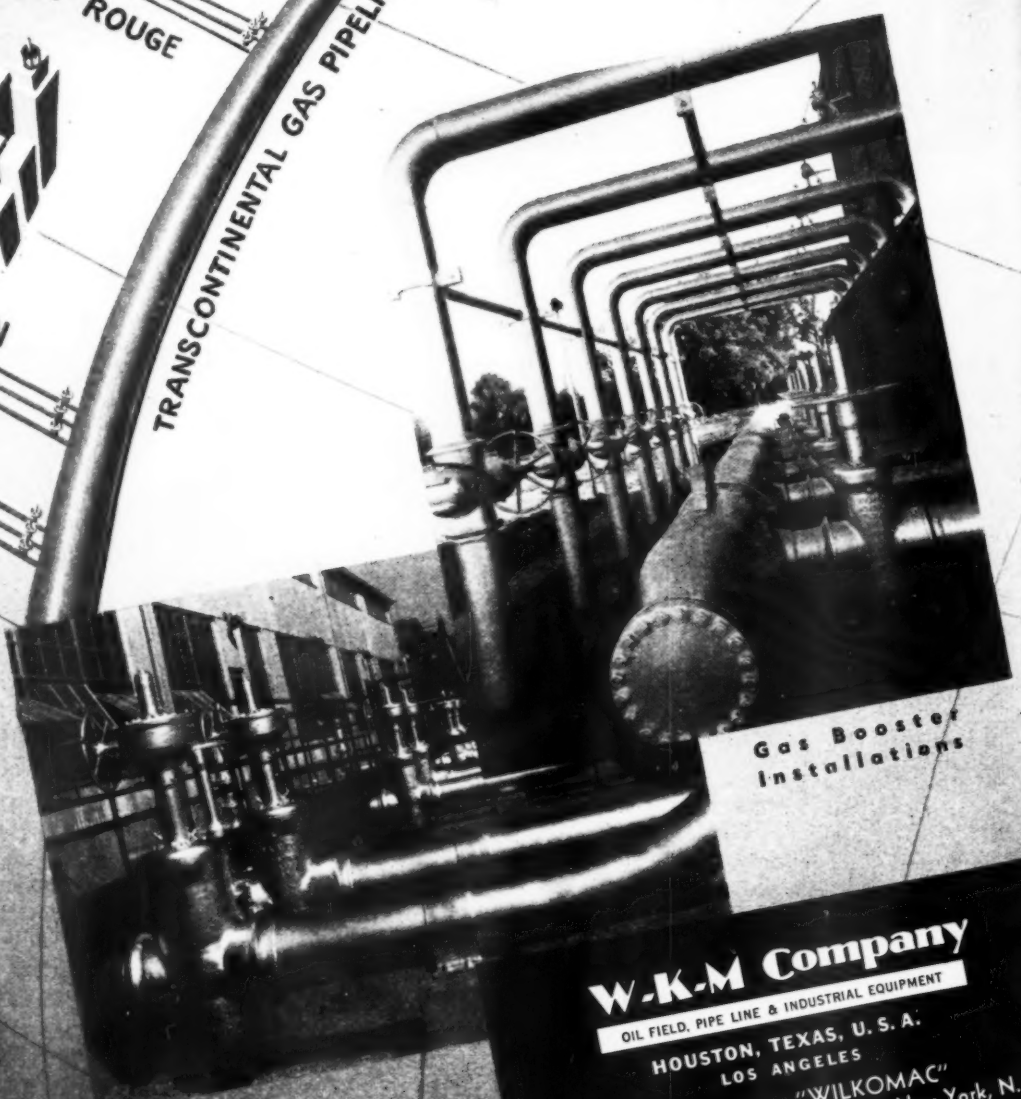
TRANSCONTINENTAL GAS PIPELINE



Gas Booster Installations

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AEROTEC GAS SCRUBBERS KEEP THE *Big Inch* CLEAN

Fig. 1. Four Aerotec Gas Scrubbers, each designed to handle 100,000,000 SCFD at an operating pressure of approximately 700 psig, as installed at the Waynesburg, Pennsylvania station of the "Big Inch" showing method of manifolding to total 400,000,000 SCFD capacity.

From Texas to Pennsylvania, Aerotec Gas Scrubbers, stationed along the BIG INCH, remove water, distillates and dust.

Above is the Aerotec installation at Waynesburg, Pa. Installed for Texas Eastern Transmission Corporation, this 400,000,000 SCFD unit is typical of manifolding possible, with standard 100,000,000 SCFD units, for increasing capacity.

The Aerotec method of separating gas from foreign material is a dry process. Since no oil or other liquid is used for separation, no carryover of these cleaning mediums into the gas stream is possible. This basic advantage eliminates the difficulties normally encountered in conventional types of scrubbers.

Aerotec Gas Scrubbers are available in practically any size up to 100,000,000 SCFD. For larger capacities, units may be manifolded as described above.

Catalog 501 on this new method is available on request. Write for it today!

Project and Sales Engineers

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THE AEROTEC CORPORATION

GREENWICH, CONN.

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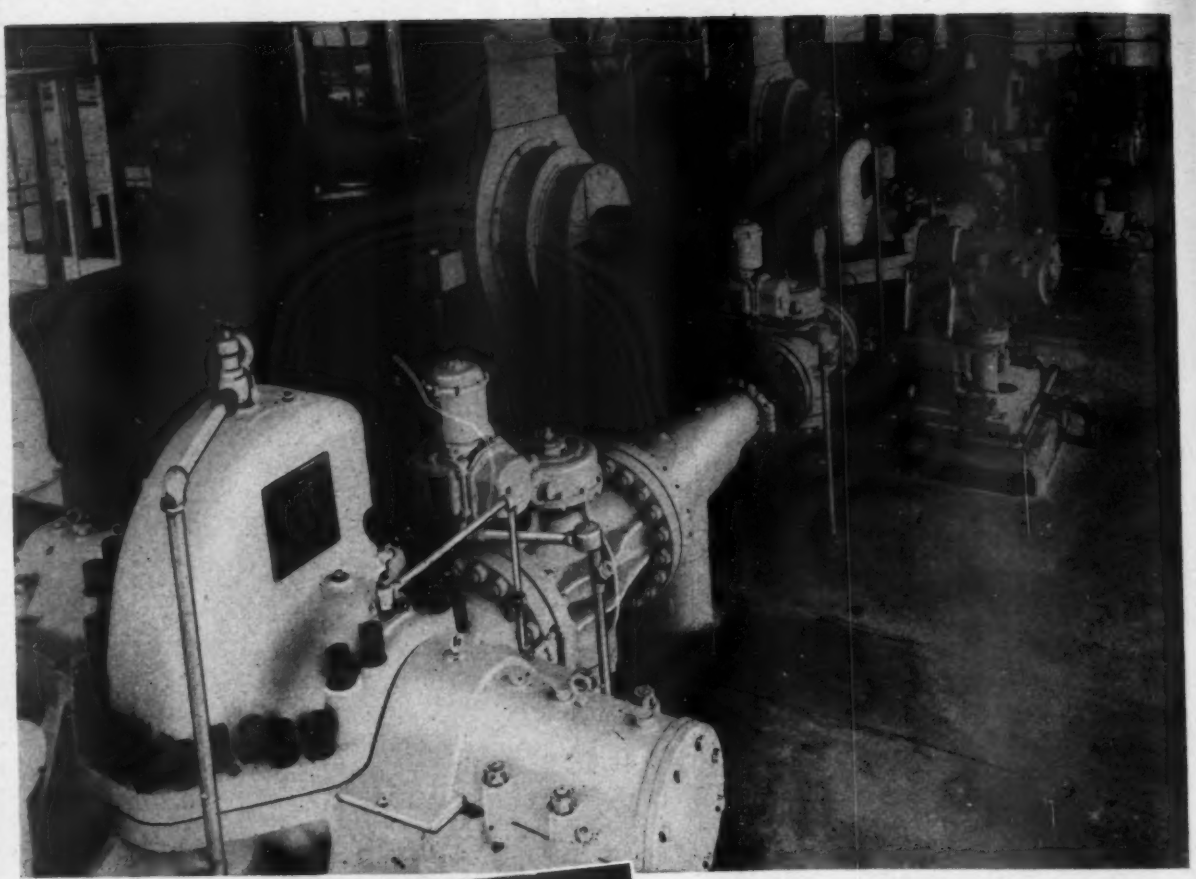
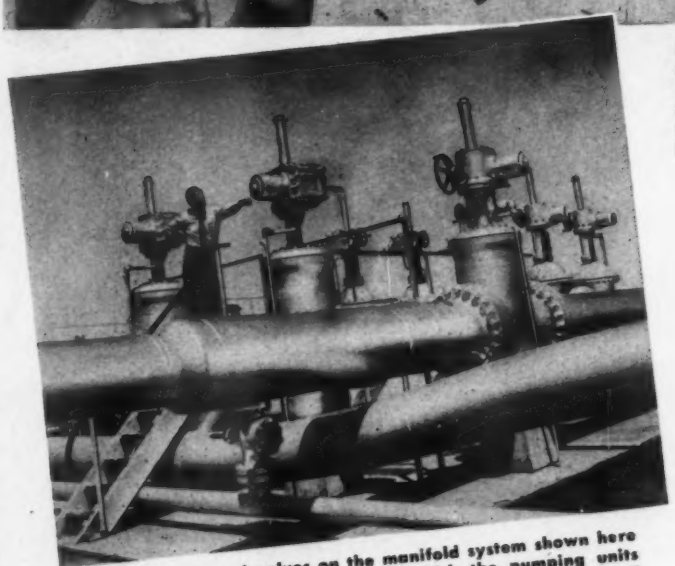


Interior view of a new and modern pipe line pump station showing three 1250 hp and one 500 hp, 1800 rpm, 4000 volt motors, direct connected to centrifugal pumps. This combination of motors and pumps provides great flexibility for varying throughput.



Motor operated valves on the manifold system shown here add greatly to the speed with which the pumping units may be put on the line or taken out of service. All motors are controlled from a central control board of the console type, simply by pushing buttons.

High Efficiency-- Low Power Cost

The use of utility electric service in this modern pipe line has made it possible for this line to be operated at a maximum efficiency at the lowest power cost. Modern automatic controls, together with safety and protective devices effect a great saving in manpower. Low original investment, with correspondingly less fixed charges, low maintenance, and high salvage value are advantages that users of utility electric service in pipe line operation can expect.

TEXAS ELECTRIC SERVICE COMPANY

R/M No. 376...a sturdy braid-over-braid packing to meet "hot" oil conditions

"Sturdy braid-over-braid construction. Resistant to 'hot' oil and petroleum fractions."

Those few words are the boiled-down story of R/M's special oil-resistant packing No. 376.

This packing was designed to meet the unusual problems of the oil industry. It is made of highest quality asbestos yarn, braided for extra strength.

It is impregnated with an oil-resistant compound for use against gasolines, naphthas, solvents, fuel oils, lubricating oils, crude oils, and other petroleum products.

For full information on the complete line of R/M packings for the oil industry, talk to your oil-field supply store or write us.

RAYBESTOS-MANHATTAN, INC.

PACKING DIVISION, MANHEIM, PA.

FACTORIES: Bridgeport, Conn.; Manheim, Pa.; No. Charleston, S.C.; Passaic, N.J.

RAYBESTOS-MANHATTAN, INC., Manufacturers of Packings • Asbestos Textiles • Mechanical Rubber Products • Abrasive and Diamond Wheels Rubber Covered Equipment • Brake Linings • Brake Blocks • Clutch Facings • Fan Belts • Radiator Hose • Powdered Metal Products • Bowling Balls

R M

RAYBESTOS-MANHATTAN, INC. O-90
Packing Division, Manheim, Pa.

Gentlemen:
Please send me information on R/M oil-resistant packings.

Name_____

Position_____

Company_____

Address_____

City_____ Zone_____ State_____

XUM

This Car Takes Oil Men Through ...When others can't!

DEPENDABLE "GO-ANYWHERE" TRACTION takes the new 4-Wheel-Drive Willys Station Wagon through deep-rutted mud and sand, over snow and ice, up steep grades. On good roads, you shift to conventional 2-wheel drive.

The new 4-Wheel-Drive Willys Station Wagon, with rugged all-wheel traction and the sensational new high-compression *HURRICANE* Engine, is more than a match for the toughest lease roads or sections where no roads exist.

Built on a newly engineered 4-wheel-drive chassis with a sturdy steel girder frame, 104½-inch wheelbase, this full-size car provides greater safety, roominess and comfort. There are seats for six with huge space in the rear for tools and equipment. Lift out the rear seats and you have 98 cubic feet of hauling space.

It's the car that's built for oil country. Ask your Willys dealer for a demonstration.

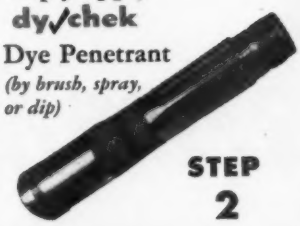
The New 4-Wheel-Drive WILLYS STATION WAGON

WILLYS-OVERLAND MOTORS, TOLEDO 1, OHIO • WORLD'S LARGEST MAKER OF 4-WHEEL DRIVE VEHICLES

Simply clean surface with **dy/chek** Cleaner

STEP 1

Simply apply **dy/chek** Dye Penetrant *(by brush, spray, or dip)*



STEP 2

Simplified Non-Destructive Testing

Simply remove excess dye with **dy/chek** Cleaner

STEP 3

Simply apply **dy/chek** Developer

STEP 4

RAPID ACCURATE INSPECTION

Any Metal—Anywhere

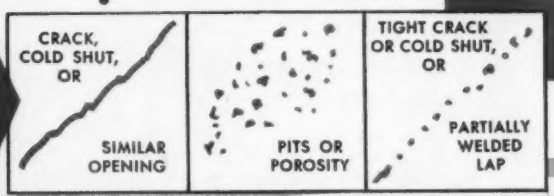
4 SIMPLE STEPS

by

dy/chek TRADE-MARK

the dye penetrant inspection method

AND... FLAWS ARE REVEALED



QUESTIONS AND ANSWERS

Q. What is Dy-Chek?

A. Dy-Chek is the revolutionary new dye penetrant method of inspection developed by *Northrop Aircraft Research.* It consists of three special liquid compounds easily applied by brush, spray, or dip.

Q. What does it do?

A. Dy-Chek reveals the location, extent, and nature of any flaw having a surface opening or discontinuity in any metal.

Q. Will Dy-Chek work on non-magnetic metals?

A. Yes, it works on *any* metal.

Q. Are special lights required?

A. No lights, booths, electricity, or special installations are necessary.

Q. What kind of metal surface can Dy-Chek inspect?

A. Any kind, including castings, forgings, machined parts, plate, sheet, tubing, pipe, and weldments.

Q. Must the surface to be inspected be specially prepared?

A. The surface need only be clean of dirt, grease, scale, etc. The surface need not be smooth.

Q. Can Dy-Chek be used in the field, for preventive maintenance, as well as in a plant for manufacturing and receiving inspection?

A. Yes, the complete portability of Dy-Chek is one of its great advantages.

LEARN HOW the Dy-Chek method of non-destructive testing can save you time and money in your business. Ask for complete details today.

dy/chek COMPANY

SOLD DIRECT

division of Northrop Aircraft, Inc.

1511 EAST BROADWAY HAWTHORNE, CALIFORNIA

dy/chek —*the dye penetrant inspection method*

Dy-Chek Company

1511 East Broadway, Hawthorne, California

Send by return mail complete details on Dy-Chek, the Dye Penetrant Method of inspection for any metal.

Name_____ Title_____

Company_____

Address_____

City_____ Zone____ State_____

XUM

Barreling on t

Progress view during construction of the 12-inch Liberty-Baton Rouge pipe line. Long, straight lengths of Republic Electric Line Pipe line up evenly and go into the ditch freely.

CHECK ALL 10 ADVANTAGES OF REPUBLIC ELECTRIC WELD LINE PIPE

1. UNIFORM ROUNDNESS—Pipe ends match perfectly . . . speed construction . . . cut costs.

2. UNIFORM DIAMETER—No "off-size" lengths to cause welding difficulties at joints.

3. UNIFORM WALL THICKNESS—Absolute dependability throughout every inch of length and circumference.

4. UNIFORM HIGH YIELD STRENGTH—Permits building higher pressure lines—utilizing design values to fullest advantage.

5. UNIFORMLY STRAIGHT Lengths line up evenly . . . go into the ditch freely.

6. EASY TO BEND—High ductility steel makes bending in the field easy.

7. EASY TO WELD—Low carbon steel welds readily . . . makes sound joints.

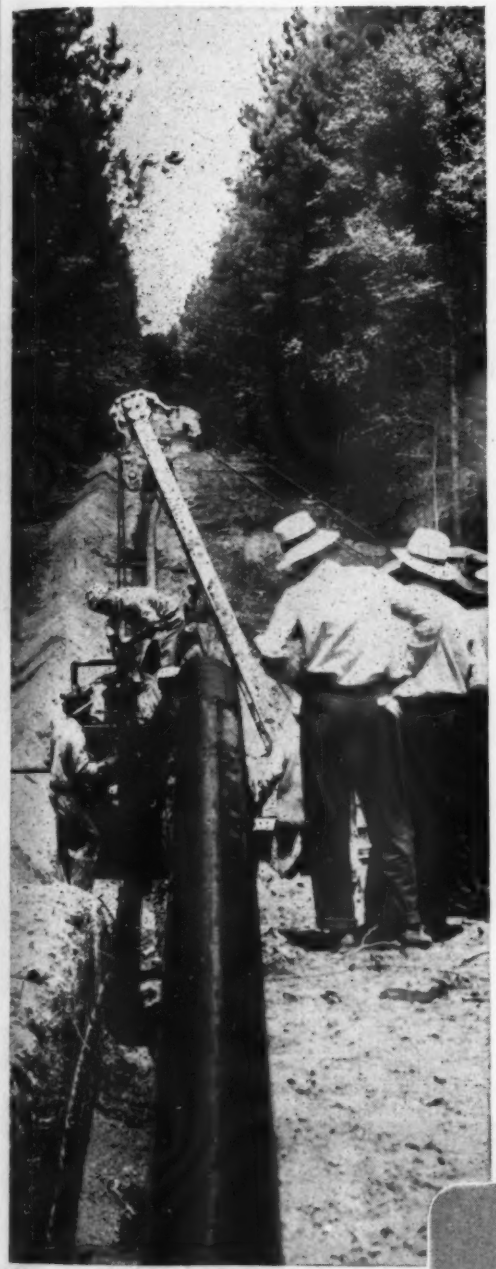
8. FREEDOM FROM SCALE—Insures against clogged valves, contamination of petroleum products.

9. LONG LENGTHS—Reduces number of joints . . . makes jobs move with longer strides.

10. INSPECTED INSIDE AND OUT—Republic Electric Weld Line Pipe is made from flat-rolled steel both sides of which are closely inspected. Thus, you are assured

that the surface which becomes the inside wall when formed into pipe is free from hidden defects.

toward Baton Rouge



Coating and wrapping Republic Electric Weld Line Pipe. Note how high ductility steel makes field-bending easy.

...ANOTHER REPUBLIC ELECTRIC WELD PIPE LINE 50 MILES LONG

● Long, straight lengths . . . ease of bending and welding . . . uniform roundness, diameter and wall thickness . . . these qualities of Republic Electric Weld Line Pipe helped hurry construction of this 12-inch line from Liberty, Mississippi to Baton Rouge, Louisiana.

Today, every barrel of fluid passing through the completed line is further protected by this *modern* pipe's freedom from scale, its uniform wall thickness and its uniform high yield strength.

All ten of its outstanding qualities are listed at left. They explain why more than 55,000 miles of Republic Electric Weld Line Pipe have been placed in service during the past 21 years. They're your assurance of its complete dependability in transporting crudes, gasoline, natural gas and by-products.

REPUBLIC STEEL CORPORATION
GENERAL OFFICES • CLEVELAND 1, OHIO
Export Department: Chrysler Building, New York 17, New York

REPUBLIC STEEL

Republic
ELECTRIC WELD LINE PIPE

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Announcing A New 15" x 3"

WARNER ELECTRIC BRAKE of ADVANCED DESIGN

Will stop 8000 lbs. Axle Loads Using 7.50x20 Dual Tires, Provides 116 sq. inches of Working Lining.

This new powerful Warner Electric Brake of two shoe construction, incorporates the most advanced brake engineering — gives you an entirely new margin of safe, effective, stopping power. Fits 18" and 20" wheels on all types of trailers — semi, cargo, pole, logging, auto transport and utility. Rigid and rugged well beyond the axle loads and sizes for which recommended. And no brake but the Warner Electric Brake offers you the fast-acting, smooth controlled braking power — power developed within the brake itself — that this great new brake gives you. Warner Electric Brakes have been performance-proved by leading tractor-trailer operators during 23 years of efficient, dependable service. Standardize on Warner Electric Brakes in your fleet. Write for information on the full line.

WARNER ELECTRIC BRAKE MFG. CO. • BELOIT, WIS.

Here's why YOU need the extra safety and protection only Warner Electric Brakes give!

Only two flexible wires required from truck battery to the brakes.

Sturdy cable connection from truck to trailer makes all electrical contacts.

Only Warner Electric Brakes offer complete synchronization with hydraulic or air-braked tractors.

"Vari-Load" dial on dash presets correct braking power.

There's nothing to get knocked-off, freeze, split or break . . . nothing to come loose, rattle and bang.

WARNER

THE ORIGINAL AND PROVEN

ELECTRIC BRAKES

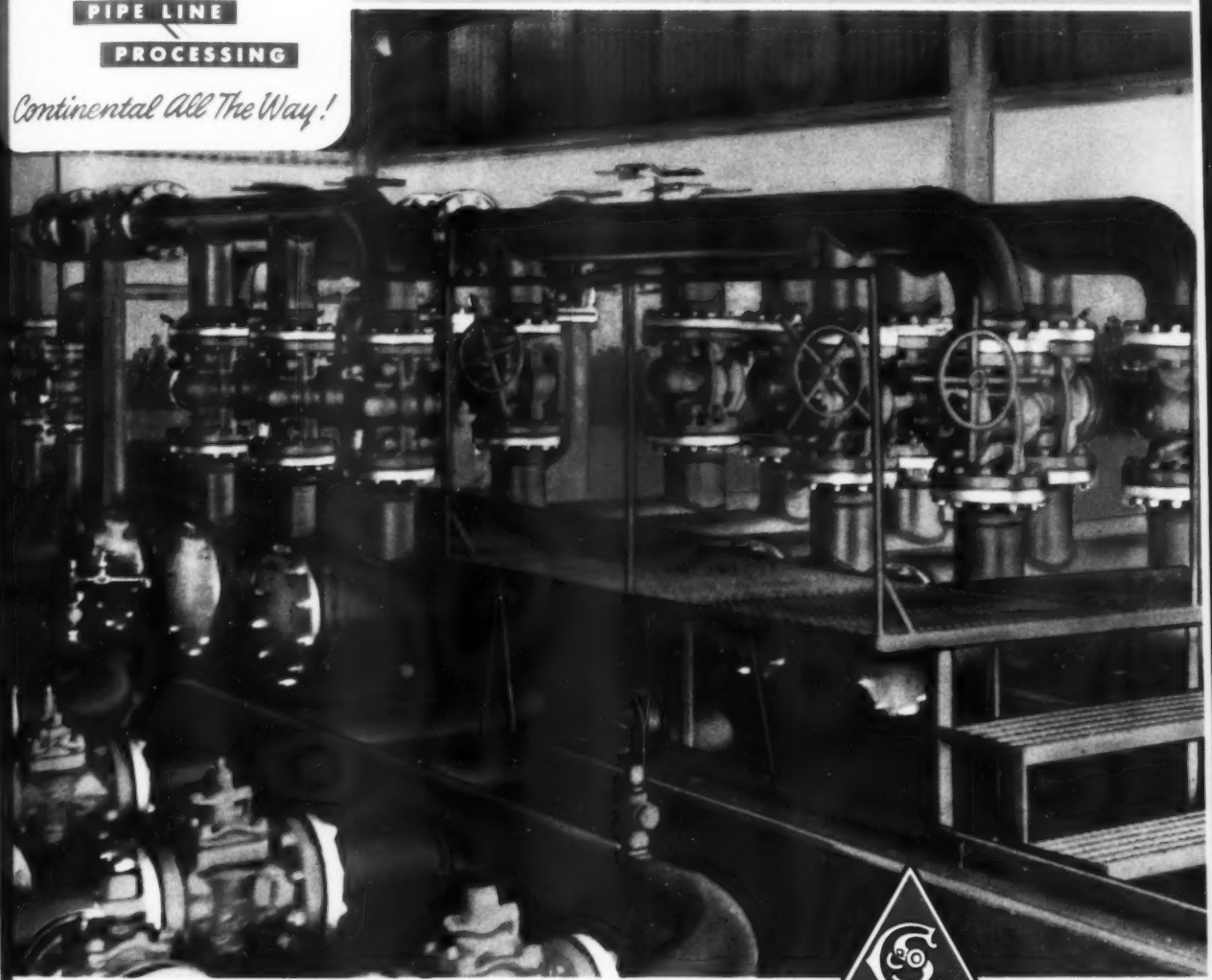
SINCE 1927

CONTINENTAL ALL THE WAY

SERVING THE PIPE LINE INDUSTRY

DRILLING
PRODUCTION
PIPE LINE
PROCESSING

Continental All The Way!



- YOUNGSTOWN PIPE
- WELDED FITTINGS
- PLUG VALVES
- F.S. FLANGES
- PRESSURE GAUGES
- PAINT

No phase of the oil and gas industries is more demanding of quality in the products used than the pipe line division.

Continental has for long recognized this fact. But more, the necessity for good service in getting supplies and equipment to the job . . . where and when needed . . . is also a must.

A network of over 70 "Green Triangle" stores and offices throughout the oil country makes such dependable service possible.

CONTINENTAL

SERVING THE OIL AND GAS INDUSTRIES

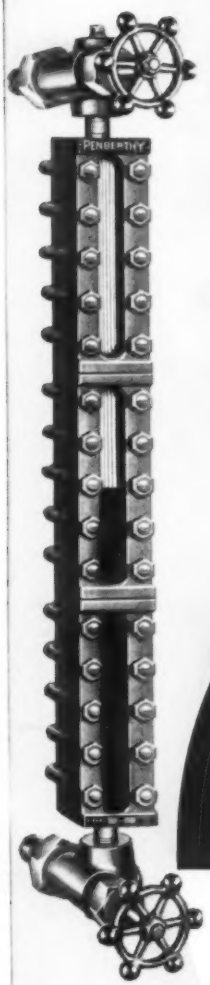
THE CONTINENTAL SUPPLY COMPANY, *General Offices:* DALLAS, TEXAS

THE CONTINENTAL SUPPLY COMPANY, LIMITED
216 Lancaster Building — Calgary, Alberta

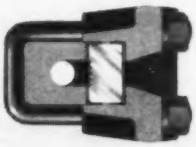
Export Division: THE CONTINENTAL SUPPLY CO., INC.
30 Rockefeller Plaza — New York, N.Y.

Representatives ARGENTINA • BOLIVIA • BRAZIL • CHILE • COLOMBIA • ENGLAND • ECUADOR • PERU • TRINIDAD • URUGUAY • VENEZUELA

XUM

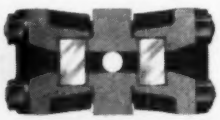


REFLEX

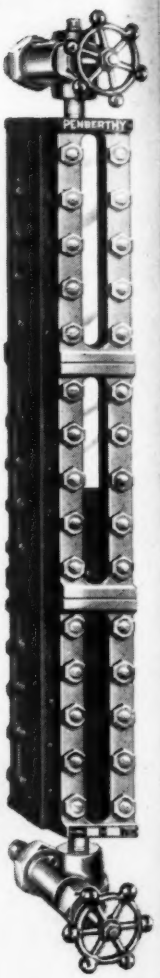


Shows empty space *white*—liquid *black* by means of a simple, unvariable optical principle. Read it accurately as far as you can distinguish black and white.

TRANSPARENT



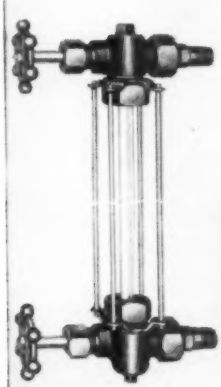
Used to observe color and density of liquids under high pressures and/or temperatures. Exceptionally sturdy construction—liquid chamber machined from solid block of metal.



PENBERTHY LIQUID LEVEL GAGES *Meet All Oil Industry Needs*

Penberthy Gages are made in a wide variety of types and sizes to meet all liquid level gaging needs in the oil industry. Four popular models are shown here. Many others (both standard and special) are available to suit all conditions of pressure and temperature. Penberthy Gages are built to the most rigid standards of quality and have the highest reputation in the oil industry. Conform with API-ASME Standards.

Write for new Catalog No. 35.

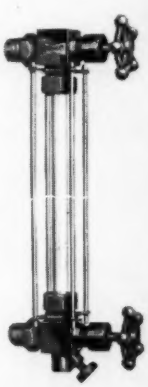


DROP FORGED STEEL

Chrome-Moly temperature resisting steel body, stainless steel trim. With or without regrinding removable seats. Tubular glass type.

ALL IRON

Tubular glass type, extra heavy body of special high strength alloy iron. Trim stainless steel, shanks alloy steel. Self-cleaning valves.



PENBERTHY PRODUCTS

PENBERTHY INJECTOR COMPANY

DETROIT 2, MICHIGAN

Established in 1886 — *Canadian Plant, Windsor, Ontario*

4151

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They Say—

Reduce Expenses

"The federal Government has used whipped-up fears of depression and war to extend its functions and increase its power. This subtle feeling of insecurity — this implantation of an anxiety neurosis — has greatly increased the power, structure and function of the federal Government at the expense of local and state governments, and it was done with taxes collected from every man who works for a living.

"The cost of operating the federal Government this past fiscal year, but not including the servicing of a massive debt, is more than 10 times what it cost in 1931.

"The first obligation today of Congress and the administration is to reduce the nonmilitary expenditures of government and to reduce them drastically, even ruthlessly, to the end that this nation shall survive the crisis before it."

N. R. Patterson, director of the National Association of Manufacturers and president of Patterson Steel Co. speaking to the Tulsa Rotary Club.

Ties that Bind

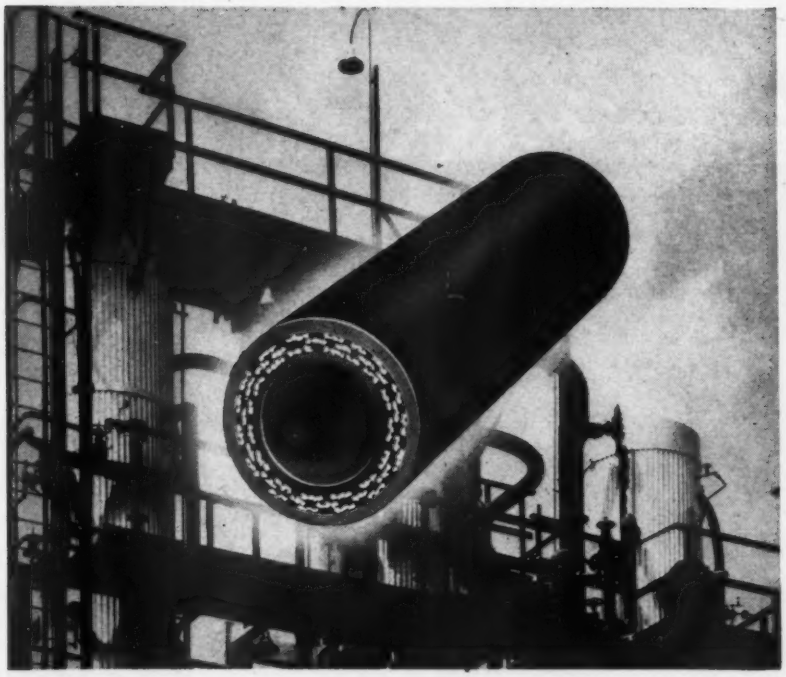
"We like to think of the pipe lines of America as an example of national strength, whether we are at peace or at war. They tie and bind together our nation and the people of our nation. Where employment is found, where strength is used, pipe lines are essential to the welfare of our country."

James F. Oates, Jr., chairman of the board, Texas Illinois Natural Gas Pipeline Co.

Cracking a Necessity

"The installation of this catalytic cracking unit is particularly timely in view of the Korean War and unsettled state of the world today. It was our superiority in high-octane fuel that turned the tide against Hitler. High-octane gasoline enabled us to double the payload of our bombers. Our planes were able to take off from shorter runways and reach high altitudes in much less time than those of the enemy which were powered by inferior fuels. In combat, our planes had greater speed and maneuverability and thereby obtained the advantage over the enemy

"To maintain our position during the last war, 600,000 bbl. of aviation gasoline were produced every day and I believe that at least double that amount of aircraft fuels will be



Turn on the Steam . . .
THIS HOSE CAN TAKE IT!

When you work with steam, high heat and high pressure play havoc with conventional steam hose. It takes a hose *built for the job* to carry saturated steam at temperatures up to 388° and pressures up to 200 lbs. . . . and do it day in and day out without failure!

Hewitt-Robins Monarch® Fiberglas* Steam Hose does just that, under the toughest kind of heavy duty service.

Here's why:

THE TUBE is an exclusive Hewitt-Robins development — a special, heat resisting rubber compound that *stays* soft and flexible without flaking or cracking.

THE CARCASS is made of multiple braids of famous Fiberglas cord — *unsurpassed for heat resistance and strength*—and heavily insulated with heat-resistant rubber. Fiberglas makes this hose kink- and rupture-proof, extremely light, flexible and easy to handle.

THE COVER is extra-tough, extra-thick, won't strip or blister . . . highly resistant to heat, abrasion and weather.

For fire fighting and all steam services in the oil industry, *there's no better hose made.*

Call your Hewitt Rubber Distributor, (listed under "Rubber Products" in the classified 'phone book) or write Hewitt Rubber Division, 240 Kensington Avenue, Buffalo 5, New York.

HEWITT-ROBINS
FIBERGLAS STEAM HOSE

*T.M. of Owens-Corning Fiberglas Corp.

HEWITT-ROBINS HR **INCORPORATED**

AIR HOSE • BARGE LOADING HOSE • FIRE HOSE • FLOATING ROOF TANK DRAINAGE HOSE
FLUE CLEANING HOSE • FUEL OIL & GASOLINE HOSE • OIL SUCTION & DISCHARGE HOSE
STEAM HOSE • TRUCK TRANSPORT & TANK CAR DISCHARGE-SUCTION HOSE • TANK TRUCK HOSE
WATER HOSE • PROPANE-BUTANE HOSE FOR HANDLING LIQUEFIED PETROLEUM GASES
CONVEYOR BELTING • PIPE SLINGS • RUBBERLOKT® WIRE WHEEL BRUSHES

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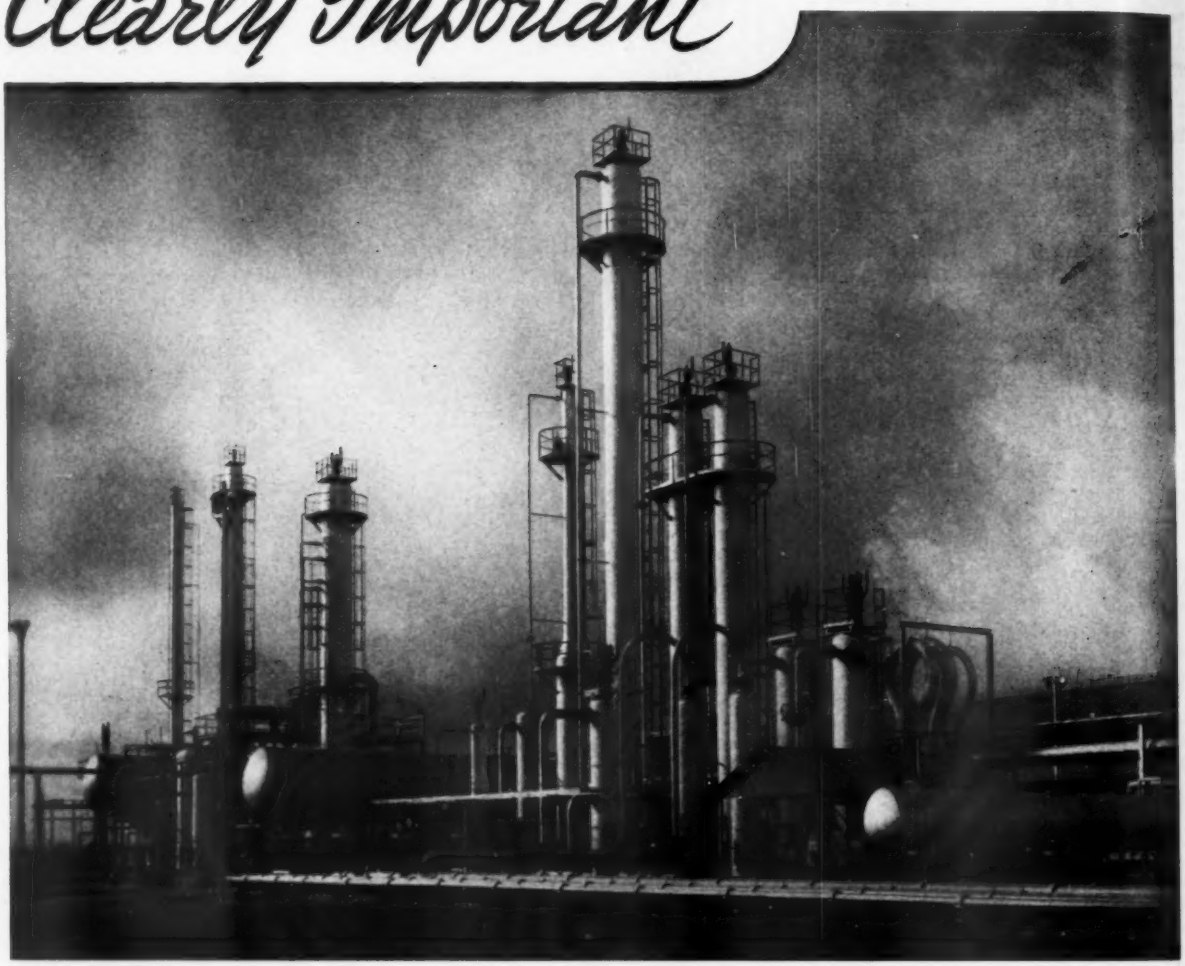
Clearly Important IN MODERN INDUSTRY



NEWALLS

HEAT, COLD AND SOUND

for All Temperatures from minus 300°F to 2000°F

INSULATION

Newalls 85% Magnesia covers temperatures up to 625° F while Newalls Newtempheit and E.H.T. Newtempheit will withstand 1625°F and 1830°F respectively. For the higher range of temperatures Newalls Insulating bricks provide efficient and economic insulation.

For the insulation of refrigeration plant Newalls Cork slabs and sections have been successfully and extensively used since their introduction in 1902. Further information on Heat, Cold and Sound insulating materials available on request.

NEWALLS INSULATION CO., LTD HEAD OFFICE **WASHINGTON, CO. DURHAM, ENGLAND**

A MEMBER OF THE TURNER AND NEWALL ORGANISATION

Telephone: Lowfell 76035 (3 lines). Telegrams: "Newsulate" Washington Station.

necessary in the event of another large-scale war.

"In war or peace, catalytic cracking is a necessity to our modern life. It is a remarkably versatile process which can be operated to meet emergencies and rapidly changing demands. . . ."

Gustav Egloff, research director, Universal Oil Products Co., Chicago, in a speech made at dedication ceremonies of modernized Deep Rock Oil Corp. refinery at Cushing, Okla.

Oil Reservoir of Future

"After 28 years of consistent discovery and constantly increasing activity, West Texas is currently called the American oil reservoir of the future.

"Within 75 miles of Lubbock, on the Northwest Panhandle Plains, are 54 oil and gas fields with 6,462 wells producing on allowables averaging 350,486 bbl. a day. To 1950, the area had produced 245,818,462 bbl. of oil.

"Its proven area of production spreads over 11,309,000 acres. Most of the development has taken place since World War II. Five years ago the 75-mile hub around Lubbock contained only 12 fields, producing 106,028 bbl. a day. Now it has 42 fields and 4,183 wells have been added.

"Quickest increase has been in the Canyon Reef fields of Scurry and adjoining counties. Geologists differ as to the probable extent and directional trend of these reefs. However, as Lubbock is located near the north rim of the Permian basin, it is feasible to predict that additional fields in the Canyon Reef lime will be brought into production within the area.

"With anticipated additional production almost certain to materialize from the Canyon Reef structures, together with a continuation of the production practices now being followed in our producing fields, I have every reason to believe that prosperity now being enjoyed by the industry in this area will continue unabated."

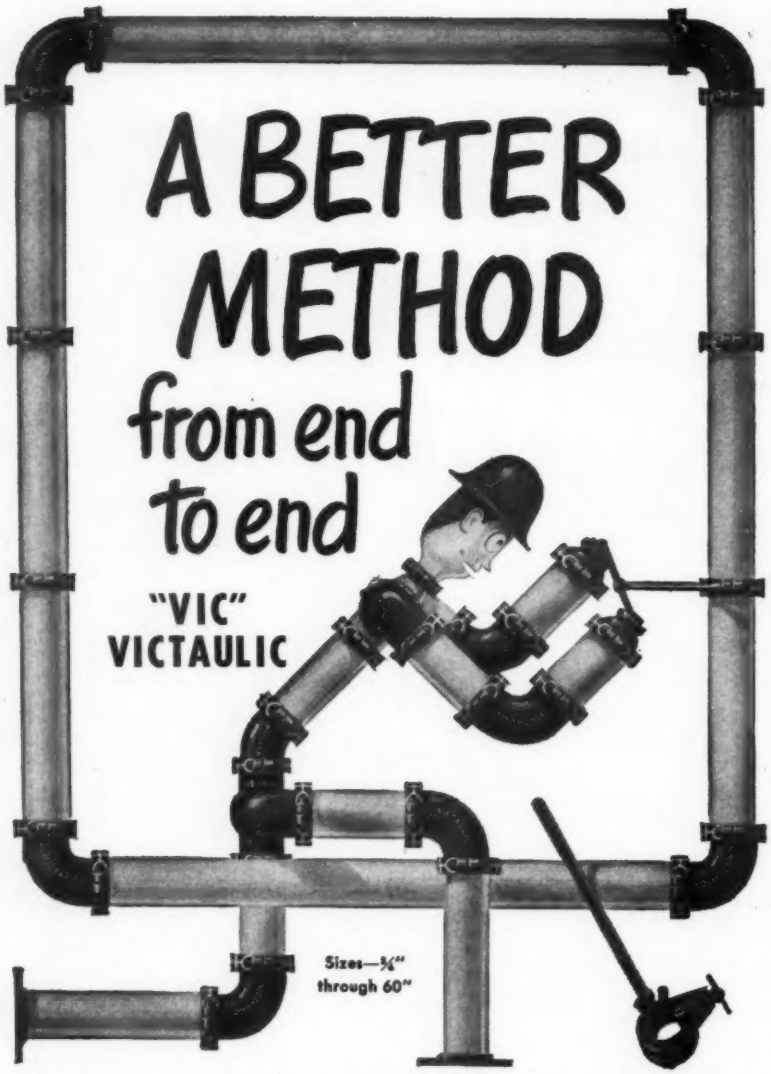
Ernest O. Thompson, senior member of the Texas Railroad Commission, speaking in Lubbock, Tex.

Primary Defense Job

"Our greatest competition should come from within the organization itself. The desire of each individual—under the rules of good sportsmanship—must be to seek to do his or her job better and more efficiently, if possible, than the man or woman at the next desk or at the next job in the field. This effort should result only in a livelier spirit of cooperation in all the jobs and at all the Sunray desks from Tulsa to California and from the Gulf Coast to Canada.

"Now for the second time in one generation the United States finds

Dependable
FIRE PROTECTION...
STARTS WITH
ANSUL
water-tight
CONSTRUCTION
ANSUL
DRY CHEMICAL
FIRE EXTINGUISHER
TO OPERATE
AFTER USING
MAINTENANCE
CUTAWAY VIEW, ANSUL MODEL 20-B
The new, improved Ansul Model "B" Extinguishers have the greatest fire-killing ratings* ever attained by hand portable fire extinguishers. In addition, WATER-TIGHT CONSTRUCTION, (exclusive with ANSUL) has resulted in far greater dependability than any other dry chemical extinguisher.
In fire protection equipment, the best is none too good. Accordingly, Ansul engineers conduct continuing research for improving Ansul Extinguishers and Dry Chemical. Ansul Quality has set a high standard for newcomers in the dry chemical fire extinguisher field. This unparalleled standard of quality is constantly being raised by Ansul research and development.
Exclusive Features
Patented Nozzle assures most effective stream pattern . . . Best results by inexperienced operators.
Special packings in Nozzle and other parts exclude water.
Corrosion resistant construction throughout.
Easy on-the-spot Recharging (No tools needed).
Quick, positive puncture operation.
Special cartridge guard protects cartridge . . . rugged construction throughout.
Ansul "PLUS-FIFTY" Dry Chemical used exclusively.
Field tested by thousands of satisfied customers.
Send for File No. 615. You will receive a variety of helpful printed matter. Included is our latest catalog which describes Ansul Extinguishers of all sizes — from the small Ansul Model 4 to Ansul Piped Systems and Ansul 2000 lb. Stationary Units.
*Factory Mutual Laboratory Reports of Examinations and Tests.
ANSUL
CHEMICAL COMPANY
FIRE EXTINGUISHER DIVISION
MARINETTE • WISCONSIN
DISTRIBUTORS
IN ALL PRINCIPAL CITIES IN THE U. S. A., CANADA AND OTHER COUNTRIES
"PLUS-FIFTY" DRY CHEMICAL IS MORE DEPENDABLE ALL-WAYS!
ANSUL
THIS TRADE MARK ASSURES YOU OF QUALITY PRODUCTS



No matter how you look at it, VICTAULIC offers a method of piping that will save time, work, and dollars on construction and maintenance from one end of the line to the other.

The VICTAULIC METHOD is easy, quick, and sure. For joining those pipe ends—two bolts hook up Victaulic Couplings in a jiffy, a standard T-wrench is the only tool needed. AND Victaulic joints stay positive-locked, leak-proof . . . they stand up under extreme pressure, vacuum, or strain conditions!

Grooving those pipe ends is a cinch with the VICTAULIC METHOD . . . "Vic-Groover" grooves 'em automatically in half the time of a conventional pipe threader!

Victaulic Full-Flow Elbows, Tees, and other Fittings are designed for free-flowing efficiency . . . to give complete versatility and dependability to the VICTAULIC METHOD.

You just can't beat the COMPLETE Victaulic System for efficient piping construction . . . it's the EASIEST WAY TO MAKE ENDS MEET.

* * *

Make *your* next piping job ALL VICTAULIC. Write today for these two: Victaulic Catalog and Engineering Manual No. 44, "Vic-Groover" Catalog No. VG-47.

VICTAULIC COMPANY OF AMERICA
30 Rockefeller Plaza, New York 20, N. Y.

Victaulic Inc., 727 W. 7th St., Los Angeles 14, Calif.
Victaulic Company of Canada, Ltd., 200 Bay Street, Toronto 1
For Export outside U.S. & Canada: PIPECO Couplings & Fittings; Pipe Couplings, Inc., 30 Rockefeller Plaza, New York 20, N.Y.

26TH VICTAULIC YEAR

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The easiest way to make ends meet
VICTAULIC
PIPE COUPLINGS AND FITTINGS

itself forced to assume gigantic financial burdens and, it would appear, a terrifying drain of manpower because of the imperialistic ambitions of wilful foreign dictators.

"There is no disputing the wisdom of a powerful program of defense. Some of our closest friends and business associates will be among those who put on the uniform to fight in this mad war. As representatives of the oil industry we must be prompt to meet our individual and collective obligations. We must comb our leases with a fine tooth comb and wash out by water flood and any means possible more oil from acreage hitherto considered to be 'washed up.' Wherever there is known to be a small hope for a new field our seismograph and drilling bits must seek it out.

"Sunray's primary national defense job is to get more oil. . . . to produce it more and more efficiently. . . . and to refine more and more barrels of petroleum into motor gasoline, diesel fuels, and aviation products. If we hold up our end of this war in such a fashion—the American men and women on the actual fighting front will more than hold up theirs, as they always have.

"Our job is to drive our business—we cannot ever afford to let it drive us."

C. H. Wright, president of Sunray Oil Corp., in "The Sunray News."

American Weapon

"American business and industrial management never are satisfied with the status quo, and this is the great distinguishing mark of the American system—and one of the greatest sources of its strength.

"Early this year we looked over a detailed study made by our economic division on the probable demand for automobiles each year for the next 10 years, taking into consideration all factors. We then estimated the percentage of that demand for which we are setting our sights this year, next year, and 10 years from now. Confidentially it was an increasing hunk each year.

"On the basis of these estimates our company went forward with a $600,000,000 expansion program. Yet we do not have any guarantee as to what the market will be in 1960. Nobody knows even what 1951 or 1952 will bring. But we have no more use for any status quo than we have for a blueprint of the Model T.

"The first characteristic of the American industrial system is this willingness to judge the future, prepare for change, and take risks. America's power to produce is far greater today than 5 years ago, and can be made still greater, and that is the tremendous American weapon, far greater than our atom bombs."

Ernest R. Breech, executive vice president, Ford Motor Co., speaking to the Economic Club of Detroit.

Millions of feet in actual use...

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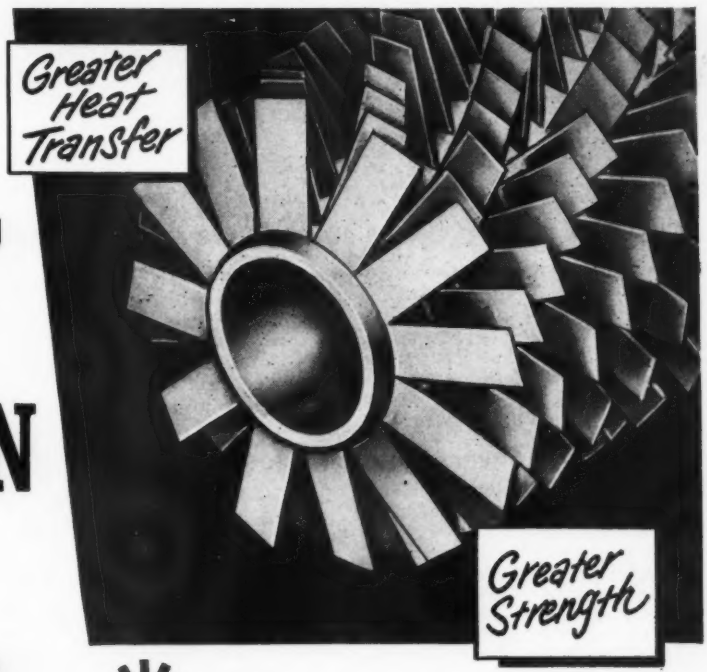

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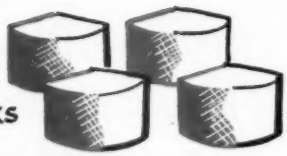
XUM

Easy Lesson in CONSERVATION ECONOMICS

If you have several cone roof tanks



that can be interconnected,

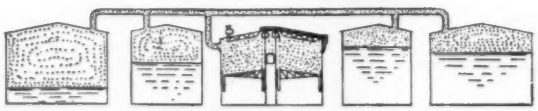
you can convert breathing losses

and filling losses

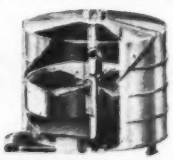
into profits quickly. Field studies at a typical gasoline plant

show $aving$ of more than 5,000 gallons

a week when six cone roof tanks were hooked up

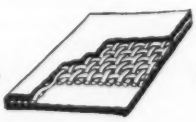


with a Wiggins DRY SEAL Gasholder.



Including expenses,

amortization took less than 20 months. What's more, the Wiggins 100% DRY SEAL



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and snow

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JOURNALLY Speaking

It's No Pipe

WANNA build a pipe line? Very simple. We tell you how in 11 basic steps, just like learning to dance. Turn to page 192 and start on our first lesson. When you get through the entire course of 11 lessons you may think you are a pipe liner. But wait. There's a postgraduate course farther along.

For homework do a few of Spencer Hallberg's equations starting on page 214. Then draw a few charts like O. H. Moore's on page 220, first with your pockets open and then with them closed. After that you will be ready for some laboratory work, like shinnying up that tower on page 302, or skating on thin ice on page 230.

By that time you will begin to realize that there's a lot more to pipe lining than just digging a ditch and dropping in some pipe. There are even some pretty nifty tricks, not to say complicated engineering problems, in digging a ditch and dropping in pipe.

We really aren't trying to fool anybody with that "11 steps" business. We know perfectly well that it's just a sort of refresher course and that even if every one of the 422 pages in this extra-fat issue were devoted to the subject they wouldn't tell all there is to know about pipe lining. The industry moves so fast that you have to read the Big Yellow Book every week to keep up with it. A "lead-pipe cinch" may be a synonym for something easy, but it has no application to oil and gas pipe lines.

Hot-Potato Race

SCIENTISTS at the Philadelphia laboratories of Atlantic Refining Co. have worked out a method of testing engine wear by using radioactive piston rings. They send the rings to Oak Ridge, Tenn., and have the Atomic Energy Commission soak them in some byproduct of the A-bomb and return them for the experiments. Since the radioisotopes have short lives, they were worried about getting expeditious delivery. They needn't have been.

Experience has shown that such shipments are handled with the greatest of frantic dispatch. The "hot" rings are packed in heavy lead containers which make them perfectly safe to handle, but they bear ominous warning labels and the awe-inspiring Oak Ridge name, and apparently they strike terror in the hearts of expressmen all the way from Tennessee to Philly. Atlantic has had no complaints about delays in transit.

On the last lap of one recent shipment a light pickup truck screeched to a stop outside the lab. The driver gingerly juggled the fearsome package into the lobby and could hardly wait for a signature. Then he smoked down the highway for all the truck would do until he reached the safe 10-mile limit prescribed for A-bombs by the local papers —glancing furtively in the rear-view miror all the way, no doubt.

Cable Lift

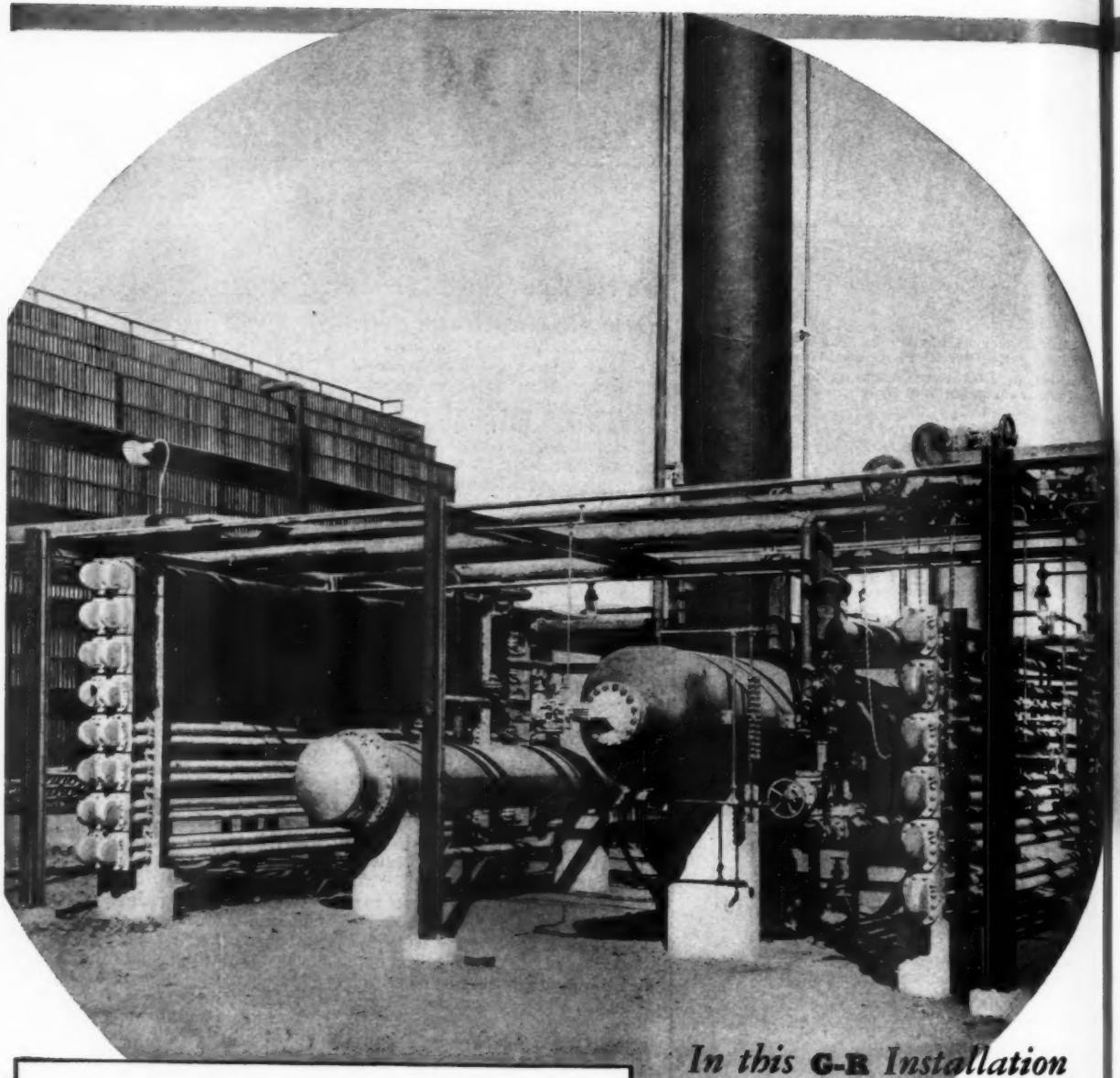
DON'T ever say the oil companies are heartless ingrates. Out in San Francisco the oil companies worked so hard to popularize motoring that they just about ran the cable cars out of business. Then they got remorseful and some of them are now "sponsoring" individual cable cars, which bear their names, and chipping in to meet the operating deficit to keep them running, just for sentiment and old time's sake. This may also give them a feeling of superiority, because if it weren't for gasoline, cable cars might be commonplace instead of tourist attractions.

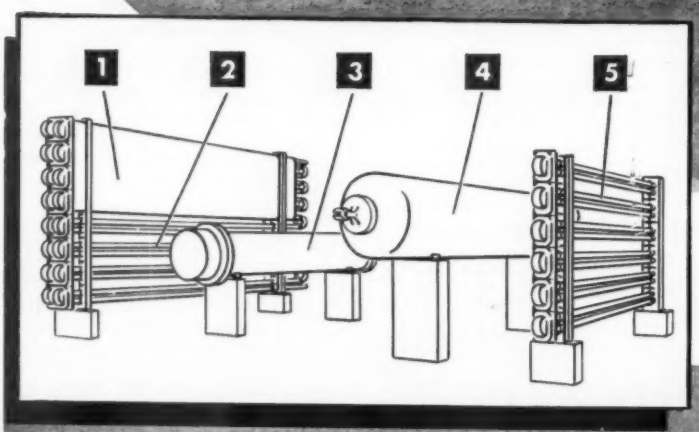
Tax Air, Too?

YOUR dealer pays more per gallon for the water he puts in your battery than he charges you per gallon for the gaoline he puts in his car. So states a leaflet distributed by the Oil Industry Information Committee. If the gasoline taxers ever get hep to that situation they're liable to move in on it.

—Henry D. Ralph

XUM





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2. 8 G-R Twin G-Fin Sections, serving as Stabilizer Cooler
3. G-R Type FLT Tubular Stabilizer Condenser
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5. 6 G-R Twin G-Fin Sections, serving as Naphtha Side-Cut Cooler

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G-R

HEAT TRANSFER APPARATUS Fully Serves a Stabilizer In This Installation

As shown in the illustration on the adjoining page, all the heat transfer apparatus required for the stabilizer at this representative refinery is of G-R design. The G-R units include cooler, exchanger, reboiler and condenser, and also naphtha side-cut cooler.

Many additional G-R units, not shown in the illustration, were also installed for other services here; for this refinery, like hundreds all over the country, standardized on G-R Heat Transfer Apparatus to assure most effective heat exchange and recovery throughout the plant.

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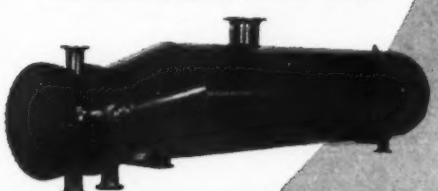

One of the designs of G-R Reboiler, available with bare tubes or K-Fin elements.

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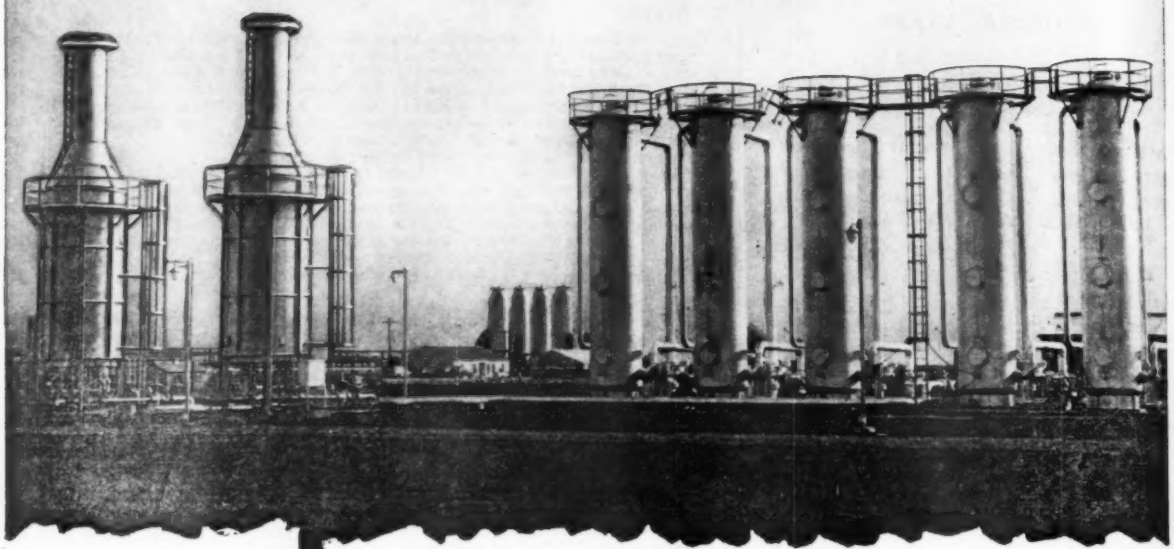

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Lines of Progress

Anyone who thinks of a pipe line as nothing more than glorified plumbing can be set straight by a perusal of the many pages of technical articles in this issue, the Journal's annual pipe-line number. Just a glance will show reliance on many branches of science and technology far removed from the steam fitter's art. A mere pipe is no more representative of a modern pipeline system than a cross tie is representative of a railroad system.

Time was, of course, when a pipe line was just a line of pipe plus a pump of sorts. The advance in pipe-line technology in recent years has been amazing, though no more amazing than the march of science through the rest of the petroleum industry. Pipe lining is fully abreast of the times.

Why? The simple pipe line of 25 years ago could move oil or gas, and did so profitably. Had these lines been public utilities there would have been a vested interest in keeping them as they were. But the oil industry consistently treated its pipe lines as plant facilities, a means to an end, that end being getting oil to market cheaper than a competitor could.

Where other industries may locate plants on the basis of existing transportation facilities, oil companies locate oil first and then build their own transportation facilities. To produce a profit during its expected lifetime, a pipe line must be operated as economically as possible, because there is always a rival in every market. This has forced the companies to make use of every possible technological advancement in construction, maintenance, and operation.

These then are the lines of progress in the pipe-line industry as well as every other industry: Private ownership, profit motive, competition, technological advance. It takes all of them working as a team to get the most progress.

In recent years a number of pipe lines have been torn up and abandoned, not because they were no longer capable of moving oil nor because there was no oil to move, but because they were obsolete, inefficient, and expensive. Their owners wrote them off to profit and loss and looked to new profits through more modern methods of pipe lining. Had these lines been public utilities there would have been much political hullabaloo about protecting investors against competition, and progress would have been slowed. Had they been government owned, their abandonment might have been impossible.

So long as the oil and gas industry owns and operates its own pipe lines and so long as the industry remains competitive, the pipe-line engineer will let no grass grow under his feet. He must constantly search for new ways to get oil to market at lower costs. This may lie in automatic instruments and remote controls, in revolutionary pumps or compressors, in methods of licking corrosion, or in some entirely new direction. The lines of progress are never clogged in this industry.

XUM

THIS WEEK

GASOLINE—Great demands to be made on petroleum industry for aviation fuels. . . . Most pressing problem facing refiners is adequately meeting military demands. . . . ¶Immediate needs to be met by diversion of alkylates and other high-octane blending stocks, but beyond this winter the picture looks complicated. . . . ¶Quality of motor gasoline for civilian use may be lowered but will still be better than during World War II. . . . Adequate supply seen, although restrictions may be used in case of all-out national emergency. . . .

INDUSTRY AFFAIRS—Petroleum-products pipe-line industry planning enlargement and modernization program to handle increased loads. . . . Trend turns toward remote-controlled, completely automatic systems which have proved more economical to operate. . . . ¶New designations may be recommended for heavy-duty lubricating oils with high detergent content. . . . ¶Reduction of two octane numbers in specifications for gasoline shipped through its lines suggested by Great Lakes Pipe Line Co.

RESEARCH—Humble Oil & Refining Co.'s new field-geophysics laboratory at Friendswood, Tex., replaces older, outmoded facilities. . . . High degree of accuracy can now be obtained through measurements, temperature control. . . . ¶Senate approves 3-year extension of Interior Department's synthetic-liquid-fuels program, and allocates an additional $27,600,000 to carry on the work.

WASHINGTON—Control of oil under Defense Production Act expected to be handled by Chapman through independent organization of Interior Department. . . . ¶Congress getting ready to recess. . . . Bills of importance to oil industry have not received action. . . . ¶Department of Justice asks Supreme Court to adopt decrees to carry out court's June 5 decisions that the Government has paramount rights to submerged lands off Texas and Louisiana coasts. . . .

INTERNATIONAL—Hopes rise that Egyptian Parliament will remove legal barriers which have virtually halted exploration for oil. . . . ¶Arabian American Oil Co.'s crude-oil production in Saudi Arabia reaches another new all-time high. . . . ¶ECA grants funds for modernization of three European refineries. . . . ¶Independent Italian refining firm orders two of smallest T.C.C. catalytic cracking units ever constructed for installation at its Genoa and Rome refineries. . . . ¶Sinclair's 35,000-bbl. Puerto La Cruz plant to go on stream October 1. . . .

ACTIVITY—Crude production for week ended September 16 averaged 5,846,375 bbl. daily, a gain of 1,009,550 bbl. daily over same week in 1949. . . . ¶Completions for the week totaled 898 compared with 850 for previous week and 711 for same week last year. . . . Wildcat completions were up 14 wells from previous week to 183. . . . ¶Rotary rigs operating in United States on September 11 totaled 2,220, up 43 rigs for the week. . . .

TRENDS—Additions to primary storage accounted for 36.6 per cent of distillate production for 2-week period ended September 9. . . . ¶Gulf-East Coast distillate stocks increased 4,002,000 bbl. . . . Mid-Continent and Middle West stocks gained 1,273,000 bbl. . . . ¶Distillate refinery demand for the period was only 3.1 per cent greater than in the same weeks in 1949 with Gulf-East Coast demand actually less than last year. . . .

REFINING—Continental Oil Co. to double charge capacity at its Lake Charles refinery. . . . ¶Standard Oil Co. (Ohio) lets contract for $5,500,000 crude-oil distillation plant at Cleveland. . . . ¶Humble Oil & Refining Co. closes permanently its 7,000-bbl. refinery at San Antonio. . . . ¶First catalytic cracking plant in Saskatchewan to be installed by British American Oil Co., Ltd., at its Moose Jaw plant. . . . ¶Mid-West Refineries, Inc., announces work is under way on U.O.P. Platforming unit at Alma, Mich. . . .

PIPE LINES—Tennessee Gas Transmission Co.'s $100,000,000 expansion program nears completion. . . . ¶Salt Lake Pipe Line Co. completes its $12,000,000 products line from Salt Lake City to Pasco, Wash. . . .

DOWN TO EARTH.—Practical, every-day information on the many steps involved in building a modern pipe line is given in a special section of this issue starting on page 187 and followed by a series of engineering and operating articles by outstanding pipe-line authorities. This is the Journal's annual pipe-line number. The picture shows a routine welding operation on the Interprovincial crude line.

War's Fuel Needs

How refiners can meet military requirements and what may be left for civilians discussed at Atlantic City forum

George Weber

ATLANTIC CITY.—Aviation gasoline presents the most pressing problem now facing the petroleum industry in meeting emergency military requirements, it was agreed by those attending the annual meeting of the National Petroleum Association here September 13-15.

How much of a problem this is and what to do about it was the subject of an open discussion by a panel of seven industry and government representatives which formed the high spot of the convention. Varying views were presented as to the future demands of the military, how the industry can meet them, and what effects this may have on civilian gasoline and other petroleum products.

Immediate needs for aviation gasoline can be met, it was conceded, by diversion of alkylates and other high-octane blending stocks from civilian motor gasoline, and a government directive requiring such diversion is believed to be imminent.

Beyond this coming winter, however, the picture looks more complicated as other potentially critical fuels, such as jet fuels and high-cetane diesel fuel, promise to become important factors.

Assuming an all-out emergency, long-range military requirements will be met by industry preparations made concurrently with government mobilization plans, the industry spokesmen declared. Despite the compounding of the problems by competition among synthetic-rubber, munitions, and petroleum industries for common ingredients of aviation gasoline, they said, expansion of certain processes can pave the way for adequate military supplies, just as in World War II.

Civilian outlook.—What will be left to civilians in the way of motor gasoline and home-heating oils was a matter of widely varying opinions. The consensus was that some reduction in quality of civilian gasoline is coming soon. How much gasoline and what octane number it will have is currently a matter of pure conjecture. However, opinions were aired, with industry representatives tending toward greater optimism than military spokesmen.

A picture of the worst that could conceivably happen to civilian supplies was presented by Lt. Col. Ray W. Whitson, chief of the technical board, of the Munitions Board Petroleum Committee. "In time of emergency," he stated, "high-octane aviation gasoline will be protected to the greatest extent, followed closely, if not on the same level, with jet fuel, assuming M-day is within the near future. Therefore, motor gasoline, both military and civilian, will consist of those components not required for aviation fuels.

"A study of the composition of any fuel must be based on many assumptions including requirements, hydrocarbon balance, and refinery capacity, and no doubt there can be as many sets of figures as there are people making estimates."

Colonel Whitson presented the accompanying table, prepared by the MBPC and submitted, not necessarily as that board's interpretation of the composition of emergency fuels, but as a basis for discussion.

COMPOSITION OF MOTOR GASOLINE

	Present (%)	
	Premium	Regular
Alkylate	2.0	....
Catalytic cracked	59.0	28.0
Straightrun, thermal cracked, and natural	20.0	62.0
Other	19.0	10.0
	100.0	100.0
TEL ml./gal. avg.	2.5	2.15
Octane No. motor method	82.2	78.8
Octane No. research method	90.7	84.3

	Emergency (%)	
	Military	Civilian
Alkylate	....	....
Catalytic cracked	22.0	11.0
Straightrun, thermal cracked, and natural	56.0	78.0
Other	22.0	11.0
	100.0	100.0
TEL ml./gal. avg.	3.0	3.0
Octane No. motor method	80-81	74.0
Octane No. research method	86-87	76.0

The 76-octane emergency civilian gasoline represents an admittedly pessimistic estimate of what might happen to such supplies by M-day plus 24 months.

Industry representatives disagreed, estimating a substantially higher octane number for civilian use. A substantially higher antiknock quality than that of civilian gasoline during World War II can be expected in any emergency, according to Dr. Graham Edgar, vice president of Ethyl Corp. He pointed to greatly expanded facilities for producing tetraethyl lead and on the basis of varying degrees of emergency predicted the qualities left over after the military would have been served *(see accompanying story "Tetraethyl Lead")*.

Process requirements. — Constructive suggestions as to what the industry can do to meet emergency requirements for high-octane aviation gasoline were presented by T. L. Apjohn of Socony-Vacuum Oil Co., Inc. Stating that it is quite probable that our ground and sea forces and those of our allies will require more petroleum products than in the last war, come an all-out war, he estimated that such increases would be marginal. Such is not the case with aviation fuels, however, he said.

High-octane gasoline successfully supplied to our air forces in the last war, comprised a 100-130 grade for combat and some military transport, while domestic military and commercial aircraft used 91-octane fuels satisfactorily. This situation would no longer hold in another similar effort, for 115-145 grade is now required for combat while commercial and domestic military needs would demand the quality formerly used in combat.

This increase in quality poses greater problems in production of aviation-gasoline components, which problems are further compounded by immediate shortages in aromatics and by potential shortages indicated by increased production of synthetic rubber and munitions.

Top priority was given to the problem of alkylate production, since the required volumes will be swelled not only by anticipated increases in military consumption over the last war, but also by the fact that higher-quality alkylate will be necessary as well as a higher percentage of that component for each barrel of military product. While alkylation feed stocks will be largely restricted to butylenes due to the higher-quality requirements, sufficient butylene production resulting from the expansion of catalytic cracking should be available, it was estimated.

Aromatics present an important secondary requirement for anticipated aviation-gasoline production. Here the picture is dark in view of the present critical benzine shortage which would become even worse in an emergency. The industry should therefore concentrate on the types of catalytic cracking and catalytic reforming processes which yield maximum aromatic fractions.

Notice needed.—Dr. Gustav Egloff, director of research for Universal Oil Products Co., voiced industry sentiments when he stated that the oil industry can supply any demand made by the armed forces for motor fuels. However, he said, the industry needs to know a sufficient time in advance

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The panel on military requirements and civilian gasoline which conducted the forum discussion at the convention of the National Petroleum Association: Dr. Graham Edgar, vice president of Ethyl Corp., Detroit; J. R. Sabina, technical manager of du Pont's petroleum chemicals division, Wilmington; Dr. Gustav Egloff, director of research, Universal Oil Products Co., Chicago; T. L. Apjohn, research and development department, Socony-Vacuum Laboratories, Paulsboro; E. H. Fallin, N.P.A., secretary, presiding; C. M. Larson, chief consulting engineer, Sinclair Refining Co., New York; E. O. Campbell, technical branch, Munitions Board Petroleum Committee, Washington; and Lt. Col. Ray W. Whitson, chief of the technical branch, MBPC, Washington.

what volume and quality of motor fuels will be required for military and civilian purposes. He added the opinion that if fuel demands increase markedly, allocation of steel will be necessary for increasing crude production, transportation, refining, and distribution of products.

"We can't emphasize too sharply," said Egloff, "that the industry must be advised as to requirements. The military can't push a few buttons and expect millions of barrels of products to be rolling to distant points in a few days. There is no question that the oil industry will play ball if the military advises us what is needed in sufficient time to permit us to provide the necessary facilities."

Diesel fuels.—Although secondary to aviation gasoline as a current critical product, high-cetane diesel fuel threatens to approach it in importance from a strictly military standpoint, said Apjohn. Emergency needs will be largely military, but the requirements of railroads must also be considered as essential. Further complicating the picture is the indication that the Navy will require higher-quality diesel fuels.

Capt. W. C. Latrobe, director of material development of the Standards and Specifications Division of the Bureau of Ships, discussed what he termed the hazardous fuels.

"We feel that our diesel-fuel specification and our boiler-fuel specification today, are inadequate and with your cooperation we hope for an early solution of the problems confronting us, of today's diesel fuels and boiler fuels, by the development of a specification to eliminate the hazardous fuels, without curtailing your production of diesel and boiler fuels to meet our volumetric requirements," said Captain Latrobe. Because of the intimate contact of diesel fuel and salt water aboard ships, particularly submarines, the compatibility or stability of such fuels becomes a serious problem, in that they form harmful sludge and develop water-retention properties. He stated that specifications for diesel fuels containing no cracked materials were under consideration.

At the same time he presented a serious appeal to refiners to return to supplying fuel oil for the approved list and to keep abreast of requirements for stable, compatible boiler-fuel oil. The Navy is also looking for a specification to eliminate slag in residual fuels, which slag, said Latrobe, formed on superheater tubes at high operating temperatures and reduced boiler efficiency.

Presenting industry's viewpoint on the Navy diesel-fuel requirements, C. M. Larson, chief consulting engineer for Sinclair Refining Co., disagreed with the contention that a straightrun product was required. "There is a tendency to specify a straightrun component for diesel fuel on the assumption that stability would thus be insured. While a straightrun fuel usually provides a stable blend with any normal type of gas oil, stability is by no means certain in all cases. Many millions of barrels of a partly cracked fuel, or a mixture of cracked and straightrun fuel, have been used by the Navy and railroads for diesels. Such gas-oil blends have been rated as compatible with such diesel fuel oil."

In many instances the cycle side stream from catalytic cracking units, when properly blended with straightrun gas oil, will not only have stability and compatibility, but will give zero pour point to the Navy 7-0-2 diesel fuel blend, Larson continued. "Surely, this is no time to restrict fuels to straightrun components when the railroad and Navy demands will be at an all-time high. The transcontinental railroads estimate 18 to 30 per cent greater diesel-fuel consumption for 1951 over 1950."

Jet fuels.—Speaking of the effect of an all-out war need for large quantities of jet fuel, Larson stated that such need "will cut deeply into the kerosine, range oil, and No. 1 fuel production. This is more so with JP-1 than with JP-3 fuels. In addition to jet-fuel blends, these components with 560° F. maximum end point are recommended for, and used by, diesel bus engines especially of the two-cycle make, for farm-tractor distillate fuel, for range and space-heater fuels, and for many other purposes.

"The large number of diesel-powered city buses will have to use higher-end-point diesel fuels, even though the exhaust-smoke level does go up slightly. These higher-end-point No. 2 diesel fuels are being used successfully by certain city and intercity bus lines. The growth of range and cabinet-heater usage of No. 1 and range-type fuel cuts into the light distillate production, so that kerosine, range, and No. 1 fuel will be in a very tight position for such heating equipment. As for the large need for light-distillate-type farm-tractor fuel, gasoline will have to take its place." Larson added that bus-line operators would do well to consider conversion to high-propane-content L.P.G. for fuels.

Jet fuel specifications present no particular processing difficulties, said Apjohn, and can be properly blended from almost any stabilized gasoline, kerosine, and light-fuel-oil stocks,

with the exception of some thermally cracked heavy fractions of poor stability. He cautioned, however, that since the jet engine is still considered in a relatively early stage of development, the industry may face some restrictive changes in specifications in the future.

Supply of proper jet fuels does not entail the rigid requirements of reciprocating-engine fuels, he continued. The potential problem is quantity, since the specific fuel consumption of a turbo-jet engine in pounds of fuel per horsepower-hour approximates three times that of a reciprocating engine. This quantity problem, when it arises, can be met with the industry's fundamental process requirement of crude-running capacity.

Tetraethyl Lead

There will be enough to maintain antiknock quality of civilian gasoline despite possible war requirements

ATLANTIC CITY.—The antiknock quality of civilian gasoline will be better than during World War II, and probably adequate for the great majority of cars, even though the quantity may be restricted in case of an all-out national emergency, the National Petroleum Association was assured at its convention here last week.

This conclusion was advanced by Dr. Graham Edgar, vice president of Ethyl Corp., while participating in the forum on military requirements and civilian gasoline *(see companion story "War's Fuel Needs")*. He reported on expansion of capacity to produce tetraethyl lead and forecast the probable military and civilian demands for TEL.

J. R. Sabina, technical manager of the petroleum chemicals division of E. I. du Pont de Nemours & Co., the only other producer of tetraethyl lead, agreed with Dr. Edgar's estimates that TEL capacity at present is 350,000,000 lb. annually and will rise to 460,000,000 lb. by 1952.

TABLE 1—RATED CAPACITY OF TEL PLANTS
(Millions of pounds)

1941	1942	1943	1944	1945	1950	1951	1952
221	221	221	259	296	350	420	460

In support of his estimate of possible emergency fuel quality, Dr. Edgar reviewed the record of World War II, and drew a comparison with present and projected production capacity and probable military needs. "The maximum military demand for TEL occurred in 1944 with a production of 584,000 bbl. per day of all grades of aviation gasoline (over 500,000 bbl. of 100-octane) and with substantial quantities of all-purpose military gasoline," he said. "This military demand was at the rate of approximately 155,000,000 lb. of TEL per year."

The rated production capacity of TEL is shown in Table 1.

Quantity unknown.—While Dr. Edgar stated he had no direct knowledge of the estimated demand for a future emergency, in view of the increased importance of jet and turbo-prop engines which do not use TEL, he presented the opinion that it seems most improbable that the demand for aviation gasoline will exceed that of World War II, and the longer an emergency is postponed, the lesser the demand for TEL would appear to be.

Despite disagreement with this opinion from others on the panel, it conceded that any military needs for TEL could easily be taken care of. He estimated further that the capacity available for use in civilian gasoline would be several times that which was available in World War II.

Expanding his subject, Dr. Edgar made four basic assumptions which, while not presented as exact, were believed to be reasonable. His assumptions:

1. In a full-scale war, the military needs for gasoline and other fuels will require some curtailment of civilian consumption of gasoline.
2. The total volume of gasoline produced will be 40,000,000,000 gal. per year.
3. Not over 150,000,000 lb. of tetraethyl lead per year will be required for military gasoline.
4. TEL plants operate at capacity.

On these basic assumptions, the average available TEL content of civilian gasoline under different assumptions as to the percentages of the total gasoline allocated for civilian use, and different amounts of TEL going to military use, was drawn up, as shown in Table 2. These estimates take into consideration the TEL-capacity figures less an estimated 30,000,000 lb. for export, which exports will cease on completion of planned increases of TEL capacity in England by 1953.

TABLE 2—ESTIMATED TEL AVAILABLE

Millions of pounds of TEL			Civilian gasoline		
	Civilian		Per cent of 40 billion	Avg. TEL content available	
Military	1951	1952	gallons available	1951	1952
50	340	380	100	2.35	2.61
100	290	330	75	2.66	Over 3.0
150	240	280	50	Over 3.0	Over 3.0

TABLE 3—AVERAGE TEL CONTENT
(Cubic centimeters per gallon)

Year	Regular	Premium	Average
1941	1.48	2.55	1.80
1942	0.83	2.13	1.03
1943	0.89	2.27	1.23
1944	0.80	1.97	1.12
1945	1.01	2.19	1.43

These figures were compared with those of World War II years, in which civilian gasoline had average TEL content as shown in Table 3. Taking into account the percentages of premium gasoline sold during these years, the over-all average TEL content was that shown under the column termed "average."

More TEL.—"From these data," concluded Dr. Edgar, "it is clear that even with the great increase in gasoline production and consumption from World War II to the present, the average TEL content of civilian gasoline can be much higher than in the war years, and a substantially higher antiknock quality can therefore be expected.

"Furthermore, maximum military demand does not occur overnight; to increase substantially the capacity of the petroleum industry to produce the presently used 115-145 grade of aviation gasoline would require an extensive building program, and to produce the airplanes to use greatly increased quantities of gasoline takes a substantial amount of time.

"Tetraethyl lead, on the other hand, can be diverted from civilian to military use almost overnight by one of various methods of allocation, and a very small reduction in the octane number of civilian gasoline would provide very substantial quantities for military use. A relatively small war, such as that in Korea, has a hardly measurable effect on the civilian supply situation."

Regarding the outlook for continued production of tetraethyl lead at capacity during an emergency, it was stated that supplies of immediate and basic raw materials would be sufficiently available and that no curtailment of production is expected.

Heavy-Duty Lubes

New names studied for high-detergent types

ATLANTIC CITY.—New designations for heavy-duty lubricating oils with high detergent content may be recommended by a panel created by the lubrication committee of the Division of Marketing of the American Petroleum Institute meeting here September 14.

In response to requests, the committee resumed discussions of the desirability of restating the type designations of regular, premium, and heavy-duty lubricating oils. The opinion prevails that the trend of the past 2 years toward greater use of detergents has outmoded the current

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A.P.I. designations—which in turn are quoted in the Society of Automotive Engineers Handbook.

Restatement of such designations should clarify both the equipment manufacturer's specification and the customer's selection of the proper lubricating-oil type for specific uses.

High-detergent oils, now called heavy duty and super duty, will receive special attention of the panel. Preliminary thoughts on this subject point to the possibility of defining or designating four such high-additive grades.

According to some suggestions made in the open meeting, one grade may closely resemble the former military type, termed Army 2104-B, which receives continuing commercial acceptance after being dropped by the military in favor of a higher-additive oil. Arguments for continuing such a type point to the fact that it is entirely satisfactory for many civilian uses, and upgrading to conform to more severe military uses would impose a needless cost increase on consumers.

The new Military 2104 grade would of necessity comprise one of the types to be designated. In addition, two more types may or may not be defined, to conform to the types now known as Supplements 1 and 2, and containing successively higher detergent contents.

W. M. Murray of Deep Rock Oil Corp., Chicago, chairman of the committee, appointed a panel to study this matter, headed by A. L. Clayden of Sun Oil Co., Marcus Hook, Pa.

The committee also heard a report on progress of a study being conducted jointly with the medical profession on the effects of various additives on persons who handle industrial oils such as cutting oils.

More Product Lines

A.P.I. group hears of plans to expand and modernize present facilities with trend toward automatic systems

Paul Reed

ST. LOUIS.—Plans are being made by the petroleum-products pipeline industry to greatly expand and modernize existing facilities, and the trend is toward automatic and remote control systems and other installations which will bring more efficient and more economic operation.

This was indicated during the first annual Products Pipe Line Technology Conference of the American Petroleum Institute held here September 11-13, as more than 200 men connected with the industry heard discussions on problems pertinent to their branch of the petroleum business.

The amazing way in which mechanical and electrical devices are being made to hear, remember, and even smell, to facilitate pipe-line operations, received paramount attention during the 3-day conference, which also included various field trips in the St. Louis area. This was the first time that a large group of products-pipe-line engineers and operating personnel had a chance to observe and discuss developments in their field.

Sponsored by the subcommittee on products pipe-line technology of A.P.I., the conference, headed by J. W. de Groot, president of Tuscarora Oil Co., Ltd., was organized under the institute's division of transportation, Committee of Pipe Line Technology, headed by H. H. Anderson, vice president of Shell Pipe Line Corp.

Operational costs of diesel, dual-fuel, and electric power received close attention, as did the increasing use of microwave systems for pipe-line communications, operational improvements, and maintenance.

For procuring more accurate measurements, attention was directed by Norris Plank of Shell Oil Co. to correcting slippage errors in positive-displacement meters. Discussions emphasized the importance of recognizing the significance of temperature records in tank gaging, adequate tank strapping, and the effect of human error in tank-gaging operations generally.

L.P.G. problems.—G. T. Jennings, Phillips Petroleum Co., Bartlesville, Okla., delivered a paper on "Procedures in Cutting, Tapping, Maintaining, and Repairing Leaks in Field Pipe Lines Handling L.P.G. Products." He showed that cutting and tapping of lines can be satisfactorily done by use of a plugging machine and installation of "weld end" couplings.

A single, partially balanced type of mechanical seal which has been developed was discussed by M. J. Dabney, W. W. Holt and W. G. Horstman of Plantation Pipe Line Co., Atlanta. This seal has functioned for more than 10,000 hours with trouble-free operation at several installations, they said.

A revision of methods for hydraulic calculations was proposed by F. O. Stivers, Jr., Humble Pipe Line Co., Houston, in his paper on "Products Pipe Line Hydraulics." The application of an inhibitor which requires no further injection beyond refinery tankage was discussed by F. M. Watkins, Sinclair Refining Co., Independence, Kans.

Automatic stations.—Some extreme examples of completely unattended stations were discussed in a symposium on automatic and remote control. The Bear Creek station of Wyco Pipe Line Co. in Wyoming, is, for instance, equipped for automatic hydraulic control of two 125-hp. stuffing boxless pumps, the largest of this type ever installed for main-line

Those participating in a panel discussion during the pipe-line technology conference in St. Louis included, left to right: J. W. de Groot, president, Tuscarora Oil Co., Ltd., Harrisburg, who presided; L. S. Wrightsman, coordinator of natural-gasoline and products lines, Humble Pipe Line Co., Houston; C. C. Keane, chief engineer, Great Lakes Pipe Line Co., Kansas City, Mo.; W. G. Horstman, general superintendent, Plantation Pipe Line Co., Atlanta; D. C. Glass, corrosion engineer, Pure Transportation Co., Chicago; S. S. Smith, manager, products pipe lines, Shell Oil Co.; R. T. Scott, division superintendent, products pipe-line department, Standard Oil Co. (Ind.); and L. A. Baxter, superintendent of movements, Keystone Pipe Line Co., Philadelphia. The panel also included E. B. Dunn, engineer, Keystone Pipe Line Co., Philadelphia, who is not pictured.

Committee chairmen who led sessions of the first A.P.I. products pipe-line technology conference at St. Louis last week. Left to right: S. S. Smith, manager, products pipe-line department, Shell Oil Co., Inc., New York; J. W. de Groot, president, Tuscarora Oil Co., Ltd., Harrisburg, general chairman; H. E. Fisher, chief engineer, products pipe-line department, Standard Oil Co. (Ind.), Chicago; R. H. Lynch, vice president, Keystone Pipe Line Co., Philadelphia; and H. E. Dishinger, general superintendent, products pipe-line department, Shell Oil Co., Inc., New York.

service. Cost of this station is regarded as even less than of an attended station. It was stated that manufacturers are prepared to develop similar units powered by motors as large as 400 hp. as soon as the market demand warrants.

The group visited Shell Oil Co.'s New Douglas, Ill., station, where starting and stopping are done by signals from the dispatcher's office in New York City. *(For details of Shell's automatic-type pipe-line systems, see "Shell Inaugurates Automatic Products-Transmission System," The Oil and Gas Journal, July 20, 1950, page 56; and "Pipe-Line Innovation," July 27, 1950, page 158).* These signals activate an "electrical memory" so as to perform a series of timed operations for the opening and closing of valves, and the starting and stopping of pump motors. This station also is equipped with a combustible gas analyzer, which "smells" inflammable vapor mixtures either at the pump seals or on the floor, and takes samples of the atmosphere, records vapors, and, through an electrical circuit, stops the pumping unit.

The group watched operation of Shell's Vandalia, Ill., station, which is fully automatic. Operation is controlled by hydraulic pressure in the line through Hydron valve installations.

Push-buttom sequence starting of a diesel-centrifugal unit by automatic equipment was observed at Shell's Barnett, Ill., station.

In a trip to Ozark Pipe Line System's facilities in Missouri, application of comprehensive controls to crude-oil pipe-line operations was seen. Here automatic controls are justified by ease of operation, greater throughput, and more accurately controlled pressures.

Octane Reduction Suggested

KANSAS CITY. — A reduction of two octane numbers in the specifications for gasoline shipped through its lines has been suggested by Great Lakes Pipe Line Co. All refiners regularly shipping over the system have been asked to express their desires on this matter, but as yet no decision has been reached.

Great Lakes raised its specifications for gasoline last February and March, and at present the minimum requirements are 88 octane for premium gasoline and 82 octane for regular gasoline, both on the research method.

It has been rather generally anticipated by the industry that the demand for aviation gasoline by the military may require some reduction in the general octane level of civilian motor fuel, and Great Lakes' action may be viewed as preparation for such a possibility. In addition, some of the refineries connected with the system already have received military contracts to supply aviation gasoline, and these plants may have difficulty maintaining the present octane ratings of their motor fuels when in full production of aviation fuel.

Continental Anniversary

PONCA CITY, Okla.—A series of more than 40 celebrations observing the seventy-fifth anniversary of Continental Oil Co. was started here last week when the company broke ground for a new laboratory building at its Ponca City headquarters.

Gatherings of employes in 36 cities heard President L. F. McCollum speak over the largest telephone hook-up ever arranged, and this was being followed over several weeks by barbecues and other functions arranged locally by Conoco employes in 43 cities. Special advertising and displays by company dealers also are a part of the observance, designed to call attention to the fact that Continental is one of the oldest oil companies in the industry.

The theme of the celebration is preperation for another 75 years of progress. This was stressed in McCollum's address in which he cited Conoco's record in being the first to introduce a number of innovations such as the seismograph, torsion balance, core drill, repressuring, and additives for lubricating oils. It was also the theme of Dr. J. R. Killian, Jr., president of Massachusetts Institute of Technology, who addressed the Ponca City gathering by sketching how scientific research and industrial progress advance together.

NATIONAL AFFAIRS

Offshore Decree

Justice Department seeks Supreme Court's approval

WASHINGTON. — The Department of Justice last week asked the Supreme Court to adopt decrees to carry out the court's June 5 decisions that the federal Government has paramount rights in the submerged lands lying beyond the low-water mark off the coasts of Texas and Louisiana.

As part of the decrees, the department would enjoin the two states and their "privies, assigns, lessees, and other persons" from carrying on any activities in the tidelands for the purpose of taking oil, gas, or other mineral products, and declare the Government entitled to an accounting of all sums derived from the offshore areas subsequent to June 23, 1947.

In submitting the proposals of the Department of Justice, Solicitor General Philip B. Perlman explained they refrain from directing or requiring an actual accounting and payment in order to give the state and federal authorities an opportunity to agree between themselves as to the sums owing by the states. But if such an agreement cannot be reached in a reasonable time, he told the court, the department will petition for a further order relating to the ascertainment of the sums for which the states are accountable to the federal Government.

Define limits.—Since portions of the Louisiana coast are irregular and contain many indentations, the department believes it will probably be necessary to follow the procedure

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adopted in the case against California and make a determination of the particular segments of the boundary between what will be inland waters to which the state is entitled and waters beyond the low-water mark which will come under federal control. However, Perlman said, the Texas coast is relatively straight and contains few indentations, and there is no present necessity to determine any particular segments of the boundary with greater definiteness.

Perlman explained the proposal for injunctive relief is needed because of the admission by the states that they have executed leases for oil and gas development in the area sought by the Government, and that the lessees have entered upon the area and have drilled wells from which the states have received royalties.

Defense Setup

Industry experts will aid Interior Secretary Chapman in organizing war controls; Red exports heavily cut

WASHINGTON.—Oil control under the new Defense Production Act is expected to be handled by Interior Secretary Oscar L. Chapman through an organization independent of his department but tied to him through a deputy, much along the line of the Petroleum Administration for War.

The organization will cover all of the fields assigned to Interior by President Truman in his executive order relating to the priorities, allocation, and other powers granted in the new law, with separate units for oil, electric power, minerals, etc., each set up under men to be drawn from industry.

It is indicated that the petroleum agency will be practically autonomous and will be built around the Oil and Gas Division. Its first and for the present probably its only, major concern will be with aviation gasoline, and it is expected that allocation of alkylate will be undertaken as one of its first actions, probably to be accompanied by control of butylenes and other feed stocks.

Announcement of the setup is expected to come this week, and pending the development of the permanent organization the control agency probably will be staffed on an interim basis by experts in these various fields from the department, with Hugh A. Stewart, director of the Oil and Gas Division, heading the oil unit. The interim organization was set up on paper even before the Defense Production Act was enacted and can get under way immediately.

Preparing for the defense program, Stewart for several weeks has been pushing studies of the supply situation and needs for increased production of the various oil products and components. While there is nothing in the situation to require immediate application of any controls on civilian consumption, these studies have developed shortages existing or threatened in components for aviation gasoline, synthetic rubber, and other military needs, which the new organization will attack at once.

Separate organization. — Undecided for several days as to whether to administer his responsibilities under the production act within the department or by separate organization, Chapman, after conferences with representatives of the oil and other industries which will be under his control, reportedly told the coal industry he would adopt the latter course.

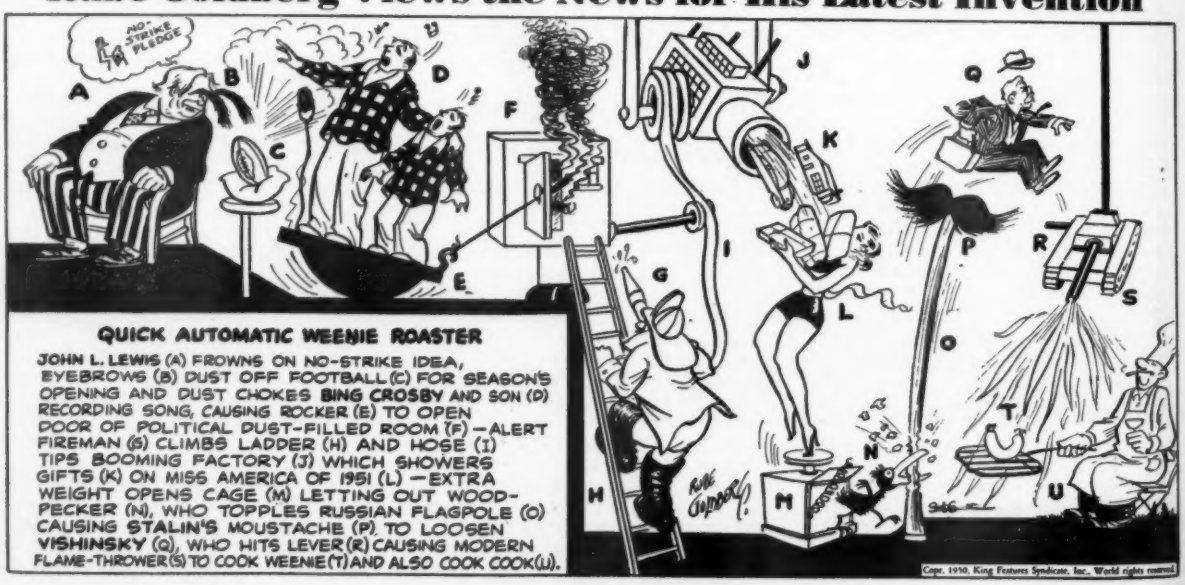
With a deputy at its head, the new agency will consist of administrative, information, and legal divisions and an operating division consisting of the several industry branches, and will have an advisory board of 8 or 10 men selected from the various industries. The oil division and the other industry branches will have a similar setup, each to be headed by a director.

While Interior moved slowly to perfect its plans before getting under way, the first days of the Government's effort to get the country on a war footing were more notable for confusion than accomplishment.

Bureaus conflict. — Commerce Secretary Charles Sawyer quickly set up the National Production Authority called for by the President to administer priorities and allocations, but the new agency almost immediately bogged down in an effort to write its first official order—controlling inventories—when other departments, notably Interior, protested that the proposed regulation covered commodities which were not under NPA jurisdiction.

There was considerable uncertainty, too, over the dividing line between the authority of the several departments which will administer the act. Commerce, for instance, has the priorities and allocation authority but Interior is responsible for the expansion of production of natural resources and electric power and feels that it should also have the say over the materials necessary for such expansion. In the case of oil this would

Rube Goldberg Views the News for His Latest Invention



QUICK AUTOMATIC WEENIE ROASTER

JOHN L. LEWIS (A) FROWNS ON NO-STRIKE IDEA, EYEBROWS (B) DUST OFF FOOTBALL (C) FOR SEASON'S OPENING AND DUST CHOKES **BING CROSBY** AND SON (D) RECORDING SONG, CAUSING ROCKER (E) TO OPEN DOOR OF POLITICAL DUST-FILLED ROOM (F) — ALERT FIREMAN (G) CLIMBS LADDER (H) AND HOSE (I) TIPS BOOMING FACTORY (J) WHICH SHOWERS GIFTS (K) ON MISS AMERICA OF 1951 (L) — EXTRA WEIGHT OPENS CAGE (M) LETTING OUT WOODPECKER (N), WHO TOPPLES RUSSIAN FLAGPOLE (O) CAUSING **STALIN'S** MOUSTACHE (P) TO LOOSEN **VISHINSKY** (Q), WHO HITS LEVER (R) CAUSING MODERN FLAME-THROWER (S) TO COOK WEENIE (T) AND ALSO COOK COOK (U).

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WATCHING WASHINGTON

Bertram F. Linz

Scrapping Already

The Defense Production Act got off to an inauspicious start last week when, less than 3 days after they were called into consultation by Commerce Secretary Charles Sawyer, steel men were yelling about red tape and dissension in Washington.

The department's press release on the first meeting to discuss priorities and allocations was little more than a statement that the meeting had been held, and steel men who attended refused to discuss the matter—in Washington. But when they got back to New York they were plenty vocal and freely predicted that unless somebody took a firm hand priorities would become mere hunting licenses, as they were during the last war, and bring about a chaotic condition.

Sorted out from less printable comment, the major charges leveled by the steel industry appear to be that the splitting of controls between a number of agencies can lead only to interminable disputes over who is to get what, and that the Commerce Department is attempting to control steel without calling in men from the steel industry to do it intelligently. Which is very reminiscent of early World War II days.

It could be that these early repercussions of Sawyer's efforts, as well as representations from industry, had something to do with Interior Secretary Oscar L. Chapman's decision to put his controls in an agency operating outside the departmental setup and bring in experienced industry men to handle them—and take the rap if anything goes wrong.

Guessing on Gas

The Federal Power Commission is doing a bit of watchful waiting to find out whether the natural-gas consuming areas are going to be short this winter, what with the great increase in the use of gas for house heating and the accelerated national-defense program.

Currently it is investigating the situation along the Panhandle system, where it is possible interruptible service may have to be cut from time to time if weather conditions are bad, but so far there is no indication that other large systems will find themselves in serious difficulties.

What may happen, however, will depend largely upon the weather. The past two winters were mild. The next may or may not be. If we get a tough winter, industrial consumers may find themselves in a spot, particularly if they are not engaged in defense production, and there is a possibility that some of the big eastern systems may have some problems.

Three years ago it was necessary to cut the gas supply of many eastern industries for days at a time in order that householders need not go cold, and the same situation might recur should next winter be as severe as 1947-48. With that in mind a number of plants have dropped plans for conversion to natural gas, according to reports reaching Washington, but right now, since nobody can foretell what the winter will be like, nobody can predict whether there will be a fuel shortage.

Alphabet Soup

Administration officials have dusted off the alphabet and are trying on various letter combinations to see how they look, particularly anxious to get some that have not been worn before.

In months to come oil men will hear much of the NPA, but it will be in connection with the National Production Authority and not the National Petroleum Association. They will find the IOB takes a hand in their material problems, and it will be the Industry Operation Bureau of NPA, which also will have an ACOPA — Advisory Committee on Priorities Administration.

There will be an ESA—Economic Stabilization Agency — which will handle price and wage stabilization, the latter through the WSB, or Wage Stabilization Board.

This, of course, is just the start, since the ball isn't really rolling yet, and other agencies with a part to play in the program will develop their own abecedarian designations. Interior, for instance, has been playing around with titles, one suggestion being the Minerals and Energy Administration—MEA, to which some irreverent wag is sure to add CULPA, making a word defined by the dictionary as meaning "through my fault."

be tubular goods, refinery equipment, etc., and Interior will be the claimant agency through which the industry will make its material needs known to the NPA, but less difficulty appears to be anticipated by officials in this field than in the field of raw minerals.

With the decision to follow the precedent set in World War II and exert such controls as may be necessary over the oil industry through a separate agency, Interior officials expressed the belief there will be little difficulty in securing the same type of men who comprised PAW and made it one of the most efficient of all the emergency agencies.

Experienced key men. — While Interior will set up an independent organization, Commerce is handling oil and other commodities through transfer to the NPA of its various commodity divisions but also will find it necessary to go to industry to secure key men since its industry experts are not technical men.

There were indications that, before the program can get rolling, there will have to be conferences between the several departments participating in it and W. Stuart Symington, head of the National Security Resources Board, who was ordered by the President to act as coordinator. Symington, however, is not to be the undisputed czar. but rather the intermediary through whom the departments will be advised of the policies and directives developed in the White House, with the job of seeing that such orders are carried out.

Within the near future, it is expected that export controls will be stiffened almost to the point of their wartime peak to protect the domestic economy against supply shortages which may result from accelerated military procurement. For the past 2 years the controls have been designed principally to prevent war material, equipment, and advanced technology from reaching the communist countries, one result of which has been to cut exports to the Soviet Union to less than 10 per cent of what they were in 1947.

Legislative Score

Oil industry unaffected by congressional session

WASHINGTON.—Congress is finally packing its bags to go home, for a while at least, and Washington this week was adding up the score.

From the standpoint of the oil industry, the most important developments of the session were the things that didn't happen.

No natural-gas or tidelands legislation was enacted, but on the other hand no repressive controls were imposed on oil. Congress knocked out the Oil and Gas Division as an inde-

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pendent unit of the Interior Department, but the Reds invaded Korea and the OGD melted into another PAW. Corporate taxes were increased and sights were set on an excess profits tax, but the old percentage depletion allowance was not disturbed.

Natural gas and tidelands were the most important questions involving oil to come before Congress. The former was quickly disposed of when President Truman vetoed the Kerr bill to exempt independent producers and gatherers from Federal Power Commission regulation and made the veto stick.

Tidelands was the subject of sporadic action all through the session as the opposing interests jockeyed for place. With neither in a dominant position, no real effort was made to bring up either a bill restoring title to the states or legislation for federal administration of the submerged oil fields. Late in the session Sen. Joseph C. O'Mahoney introduced a measure for "interim" administration —naturally by the federal Government—which never got to first base.

Amazing gyrations.—Also among the congressional failures was the so-called basing-point legislation designed to offset the Supreme Court decision in the Cement Institute case and permit sellers of oil and other commodities to quote delivered prices and absorb freight. Congress passed the bill after witnessing some amazing gyrations by the Federal Trade Commission which first fought, then approved, and still later again opposed the bill. The President had the last word when he repeated his Kerr-bill performance and, after indicating he would approve, vetoed the measuse.

On the positive side, Congress enacted legislation to permit the transfer of mineral as well as surface rights to farmers who buy land from the Department of Agriculture. To the gratification of the industry, however, it refused to consider legislation which would make leases for oil and gas development on the so-called acquired lands subject to competitive bidding.

Minor action.—All told, about 75 oil bills were introduced by the time Congress quit—many of them in the first session—and the usual number of investigations were conducted. It took something like 23,000 pages of the Congressional Record and several million words of hearings and reports to tell what Congress did this year.

Most of the bills, however, never received much consideration, including those by Sen. Guy M. Gillette of Iowa to divorce the several segments of the industry, Rep. Charles A. Wolverton's proposal for an investigation of the Mexican oil industry, and a number of measures for investigations of the Middle East oil situation, price cuts and price increases, fuel reserves, and national oil policy, as well as just plain fishing expeditions into the industry generally.

As it prepared to quit, however, the Senate approved a resolution by Sen. William Benton of Connecticut for a quickie investigation into the adequacy of fuel supplies in New England, introduced in fear that a tough winter might bring about a recurrence of the situation experienced in 1947-48.

Synthetic-Fuel Program

WASHINGTON.—A 3-year extension of the Interior Department's synthetic-liquid-fuels program and an additional $27,600,000 for the work was assured last week when Senate passed the necessary legislation and sent it to the White House for presidential approval.

The bill, previously approved by the House, was passed by the Senate only after beating off an attempt by Sen. Edward Martin of Pennsylvania to eliminate a provision of $2,600,000 for construction and equipment of an experiment station near Morgantown, W. Va., which members of the Pennsylvania delegation wanted to have located in their state.

Under the legislation, the synthetic-liquid-fuels development program, already once extended, is to be continued until April 5, 1955, and the appropriation for the work, originally set at $30,000,000, now is increased to $87,600,000.

SOUTHWEST

Texas Production

Present output may have to be cut, Murray says

HOUSTON. — The current record production rate from Texas' oil fields has reduced the state's excess productive capacity from 900,000 bbl. daily during August to 550,000 bbl. daily in September, William J. Murray, Jr., chairman of the Railroad Commission, said here last week.

He warned that shortages of materials may prevent the state from keeping up its present production rate.

The Texas Railroad Commission on September 19 ordered crude production cut back by 61,860 bbl. daily in Scurry, Kent, and Borden counties, effective September 20. Well allowables were reduced to 160 from 220 bbl. per day. The order was based on reduction in bottom-hole pressure and shortage of pipe-line outlets. It was indicated that the reduction may hold throughout October.

Speaking before the Oil Men's Club, Murray called attention to the fact that while output from fields in the state is at an all-time high, "the public does not realize the drilling effort required to maintain the record output."

Early in August the Interstate Oil Compact Commission reported that the oil fields of the United States could produce 1,139,487 bbl. daily beyond current production rates. Of this total, the excess capacity from Texas at that time was 869,968 bbl. per day. The 22-day producing period in September will result in an average calendar-day allowable of 2,823,720 bbl., or 202,836 bbl. per day more than in August. For the week ended September 9, Texas produced a daily average of 2,698,550 bbl. up 142,550 bbl. from the previous week.

GULF COAST

Discovery May Open Trend

HOUSTON.—A discovery, which may open a new producing trend on the Texas Gulf Coast, is indicated at Producers Corp. of Nevada 1 Helen Williams et al, 3½ miles north of Nixon townsite in Gonzales County.

It can be expected that there will be a rapid concentration of exploration effort centered along a trend striking northeast to southwest across Gonzales, Fayette, and Wilson counties parallel to the downdip from the Caldwell County fault trend.

The new discovery is located in the William C. Hargis Survey, Abstract 273, in southwestern Gonzales County. On a 3-hour preliminary test, the well flowed 33 bbl. of 24.8°-gravity oil per hour through a ¼-in. choke, and 7 bbl. per hour through a 9/64-in. choke, with tubing pressure of 600 psi. and casing pressure of 550 psi. Production is believed to be from the Georgetown lime. Test was made from open hole at 5,803-5,940 ft., after the hole had been plugged back from a total depth of 5,964 ft. in the Edwards lime.

Humble Sets Footage Record

HOUSTON. — A drilling crew of Humble Oil & Refining Co. in south Louisiana has set a new record by drilling 2,570 ft. in a regular 8-hour tour—321 ft. per hour—to beat the old company record of 2,448 ft.

Making hole in Lake Sand field of southern Louisiana, the day-tour crew of the company's Rig 29 set the new mark. Using a jet-type drag bit, which is a Humble development, the crew made the fast time in drilling 9⅝-in. hole from 1,910 to 4,485 ft. The evening-tour crew which took over from there made an additional 1,460 ft. with the same bit before changing

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it. The single bit drilled 3,835 ft. in 13½ hours.

The application of knowledge gained from a 6-year drilling-research program has enabled Humble to cut drilling time in many areas. *(See "Fast Drilling," The Oil and Gas Journal, August 24, 1950, page 170).* In Lake Sand field, 10,800-ft. wells are being drilled and completed in 18 days. This compares with a previous 47 to 53 days before the new equipment practices were put to use.

Expansion Planned

Conoco to double charge capacity at Lake Charles

HOUSTON. — Continental Oil Co. plans to expand facilities at its Westlake refinery near Lake Charles, La., at an estimated cost of $10,500,000, which will double its crude-oil charging capacity.

The project will increase capacity to 25,000 bbl. daily, and will include installation of a catalytic cracking unit and additional equipment for production of high-octane gasoline, L. F. McCollum, president, said.

Announcement of the enlargement program followed action by the Louisiana Department of Commerce and Industry in granting a 10-year tax exemption for the project.

Harold G. Osborn, vice president of manufacturing, will direct construction of the plant addition. Contracts will be awarded in October, and completion is scheduled for the early part of 1952.

To blend Avgas.—In addition to manufacturing a full line of domestic gasoline and heating oils, the enlarged refinery will be capable of producing high-octane aviation gasoline for the armed forces, McCollum said. A large part of the 3,000 to 4,000 bbl. daily of Avgas (115 to 145 octane) that the company has contracted to the U. S. Navy will be blended at, and move through the Westlake refinery.

Present capacity of the refinery is 11,000 bbl. daily, including 4,000 bbl. daily thermal cracking, and 1,000 bbl. daily of reforming capacity.

McCollum also announced that a new company, Continental Oil Black Co., has been formed jointly by his company and Continental Carbon Co. to produce high-abrasion carbon black from oil.

The new concern will start immediately to construct a $1,500,000 plant adjacent to the Conoco refinery at Lake Charles. The plant will use feed stock piped from the refinery and will be designed to produce 25,000,000 lb. of this black annually. The product is in particular demand for the production of synthetic rubber.

Conservation Plan Outlined

AUSTIN.—Details of a proposed program for ending the flaring of casing-head gas in the Willamar field of Willacy County, Texas, were outlined here last week by Humble Oil & Refining Co. and Pan American Production Co. at a hearing before the Texas Railroad Commission. The plan is promulgated to prevent the closing in of the field under a commission order which is to become effective October 1 unless some program for gas conservation is placed into effect.

Under the plan outlined, Humble plans to move an idle 1,000-hp. compressor from its Kelsey field compressor station to Willamar for use in injecting gas into nonassociated gas sands and other suitable injection reservoirs until a proposed joint Willamar pressure-maintenance plant is installed. R. C. Granberry, witness for Humble, said that the compressor will have a capacity of approximately 4,000,000 cu. ft. daily when operating at 20 psig. suction pressure and 2,500-psig. discharge pressure.

Research Lab

Humble experimental field station now in operation

HOUSTON. — Measurements to one ten-millionth of an inch in accuracy and temperature control to within one-hundreth of a degree can be obtained in the new ultramodern field-geophysics laboratory of Humble Oil & Refining Co. at Friendswood, Tex., 18 miles southeast of here.

The new facilities replace installations formerly maintained at nearby Pierce Junction which have been outmoded by advanced geophysical developments and exacting accuracy requirements. The work will supplement research carried on in the main geophysical laboratories located in the home office building here.

Humble scientists check calibrations on gravity meters to within one ten-millionth of an inch in accuracy. Other instruments are kept in a specially designed "hot room" built to regulate the temperature to within one one-hundredth of a degree. The wide range of temperatures that may be duplicated in this cork-insulated room may vary from that of a cool air-conditioned room to that found out in the field under a blazing sun.

One of the features of the laboratory is a radar antenna mounted on the second-floor observation tower. This is used in conjunction with the testing of modern radar techniques employed in land surveying. The use of radar in geophysical field work for surveys of marine and rugged terrain is becoming popular.

Seismic section.—In the seismic section of the laboratory, technologists may view from the many-windowed structures field operations carried on over the adjoining 300 acres while their instruments record the results in the laboratory building. Large portholes in the walls admit cables from the field leading to the instruments mounted on the inside of the building. In this connection, the laboratory is equipped with two separate darkrooms for developing the seismograph films on which the multiple traces, reproduced and amplified from the various geophones, are recorded. A specially designed "shaking table" mounted in the laboratory simulates the vibrations of the ground which occur when a charge of explosives is detonated in the field. The artificial shocks enable technicians to ascertain the sensitivity of various types of geophones.

Microscopic particles of dust which might affect precision measurements are removed electronically from the air in the windowless "clean room" in the new building.

Instrument trucks equipped with gravity, seismic, or other geophysical instruments may be driven into either of the two garage laboratories constructed in the back portion of the building. Repairs may be made of the truck instruments or experimental work may be done there. Each room is equipped with an overhead crane capable of lifting equipment weighing as much as 2 tons.

Humble Oil & Refining Co.'s new experimental field-geophysics laboratory at Friendswood, Tex., near Houston, which replaces outmoded facilities at Pierce Junction Station.

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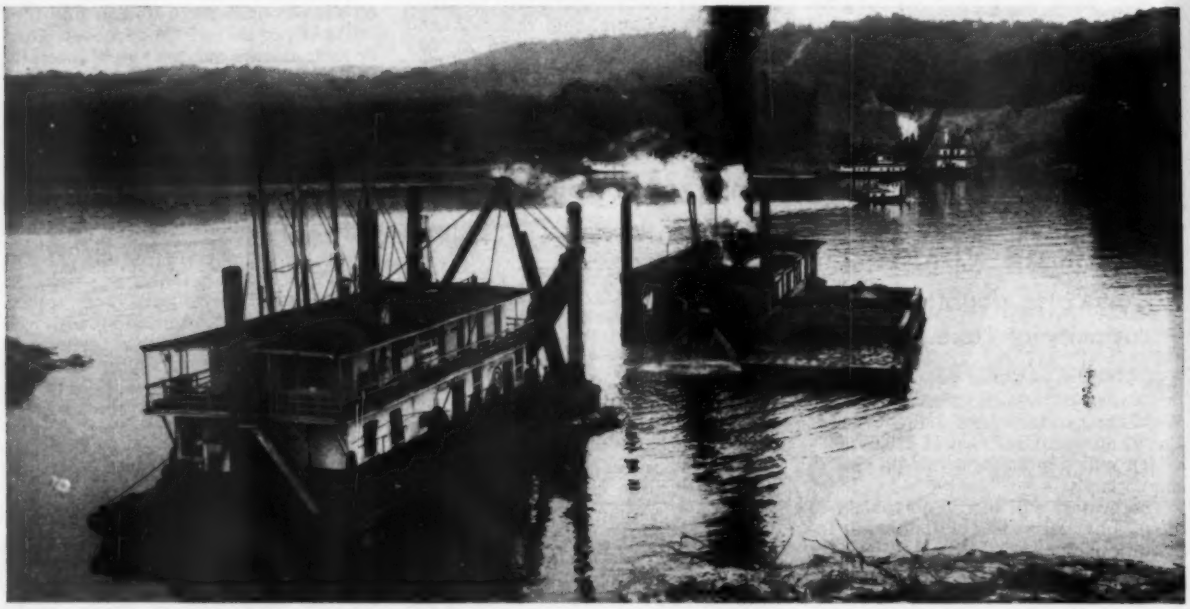


Operations at site of submerged crossing of the Ohio River near Portsmouth, Ohio, for Tennessee Gas Transmission Co. Dredges are clearing the way for two 26-in. lines, which extend from northeastern Kentucky to near Buffalo. This extension is but one portion of the company's $100,000,000 expansion program which will be completed soon.

Project Nears Finish

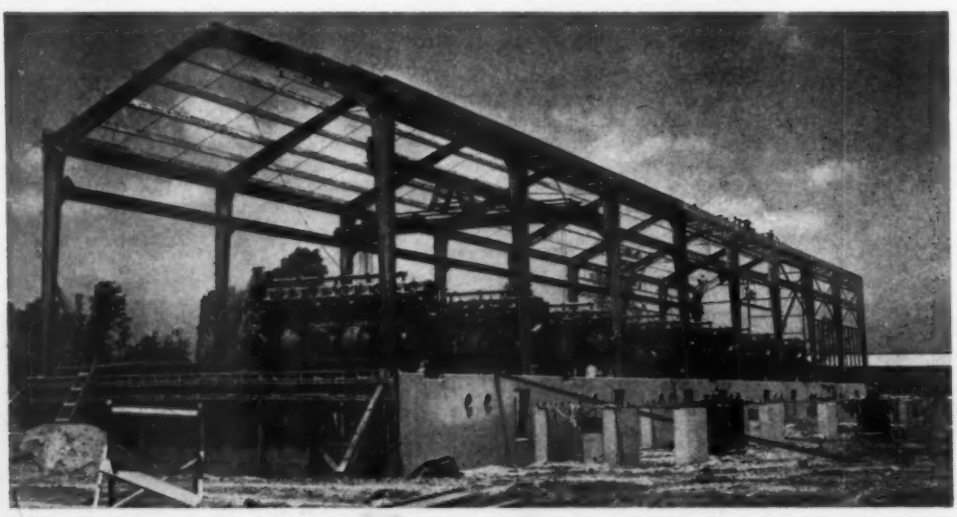
Tennessee Gas Transmission Co.'s $100,000,000 expansion program will boost daily capacity to 1,060,000 M.c.f.

HOUSTON.—Work is nearing completion on Tennessee Gas Transmission Co.'s 1950 construction program, designed to increase capacity of the firm's natural-gas system from 710,000,000 cu. ft. to 1,060,000,000 cu. ft. daily.

Costing an estimated $100,000,000, the program will enable T.G.T. to handle expanded markets in its present sales area (principally the Appalachian states), and new markets in Ohio, Pennsylvania, and New York.

The company's system now begins 24 miles from the Rio Grande in South Texas and pipes Texas and Louisiana gas 1,365 miles, with its northern terminus in West Virginia. Upon completion of the 1950 program, the system will be 1,750 miles long, stretching from Donna field, Texas, to near the northeastern shore of Lake Erie.

T.G.T.'s 1950 program is divided into two parts. In order to increase capacity so as to permit the additional deliveries, 526 miles of 30-in. and 100 miles of 26-in. pipe is being laid parallel to the existing system. With this looping done, T.G.T. will have triple parallel lines most of the way from Texas to West Virginia. Additional gathering lines are also being laid in Texas and Louisiana.



Compressor building and related auxiliary facilities for T.G.T. near Batesville, Miss. Seven 1,000-hp. compressor engines will give this station a total of 29,000 hp. compressor capacity. This is 1 of 17 stations on the company's system.

Concrete-coated 26-in. pipe being readied for laying near approaches to Mississippi River near Greenville, Miss., for T.G.T. Since spread was subject to floods, pipe was given a 2-in. coating of cement, reinforced with wire, to give added weight and protection. Map of company's complete system is shown below.

Enlarging stations. — To provide the power to move the additional supplies of gas, the company is also enlarging 10 existing compressor stations, completing a new station started last year near Agua Dulce, Tex., and constructing a new station near Load, in Greenup County, Kentucky. Fifty-four new compressor units with a total horsepower of 68,480 are being added to increase the system's total horsepower to more than 300,000.

To increase the company's markets, a 385-mile main-line extension of 26-in. pipe is being laid from Greenup County, northeastern Kentucky, across eastern Ohio and northwestern Pennsylvania to near Buffalo in western New York. This project also includes the laying of a 32-mile 16-in. lateral from the new main line near Bessemer, Pa., to near Pittsburgh.

Indicative of the final stages of completion of the company's expansion program is a report released by Latex Construction Co., Houston, last week. That firm, which has contract for several spreads in Louisiana and Arkansas, reported the following progress:

On a 99-mile 30-in. section from the vicinity of West Monroe to Natchitoches, La., 67 miles has already been completed, and work is now under way on the remaining 32 miles; on a 95-mile, 20-in. section from Natchitoches to Kinder, La., work is under way by two spread crews; and on a 102-mile, 16-in. section and an 11-mile section of 12-in. from Bayou Sale to Kinder, La., the 11-in. is nearing completion, and work is to start immediately thereafter on the 16-in.

T.G.T.'s supervisory personnel inspecting coils of a cooling tower under construction at the company's new compressor station near Load, Ky. Left to right: G. C. Rogers, district pipe-line superintendent; W. H. Gentry, party chief; Frank Smith, safety engineer; W. C. McGee, Jr., general superintendent of operations; and Gene Cochran, division superintendent.

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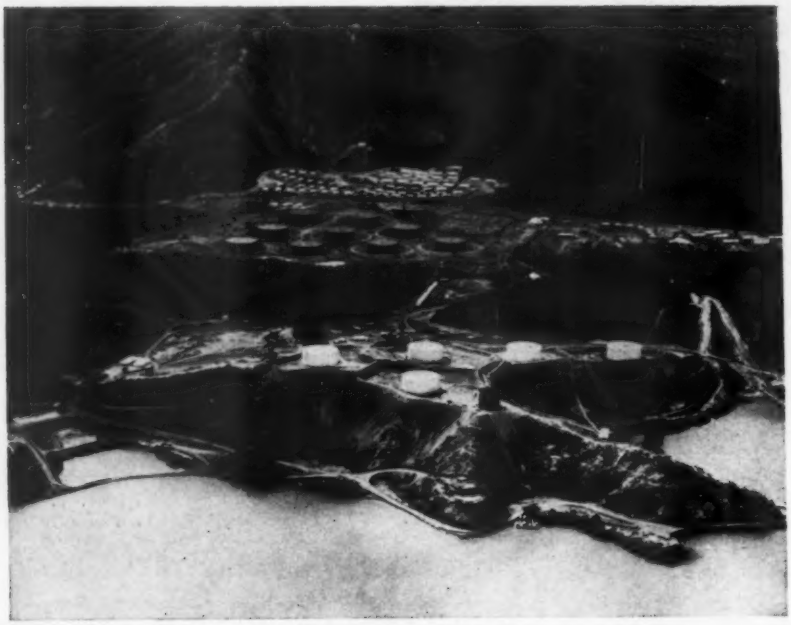


General view of Sinclair's new refinery at Puerto La Cruz, Venezuela. The process section is behind the left group of tanks in the foreground, and waste-water decontamination basins are at far left. Darker-colored tanks, center, are those built for the refinery, and back of these can be seen the employe houses.

New Venezuelan Refinery

Sinclair's 35,000-bbl. Puerto La Cruz plant will go on stream October 1 to process Santa Barbara-type crude

Dahl M. Duff

SINCLAIR OIL & REFINING CO.'s new refinery at Puerto La Cruz in eastern Venezuela will go on stream around Ooctober 1, to provide another sizable addition to that country's growing refining industry.

The new plant, now nearing completion, will have a capacity of 35,000 bbl. daily, and will process Santa Barbara-type crude into a line of major petroleum products, including gasoline, kerosine, heating oil, diesel oil, and residual. Sinclair Oil & Refining is the operating subsidiary of Venezuelan Petroleum Co. in which the majority interest is held by Sinclair Oil Corp. The new Puerto La Cruz refinery is the only refining operation of the Sinclair organization outside the United States.

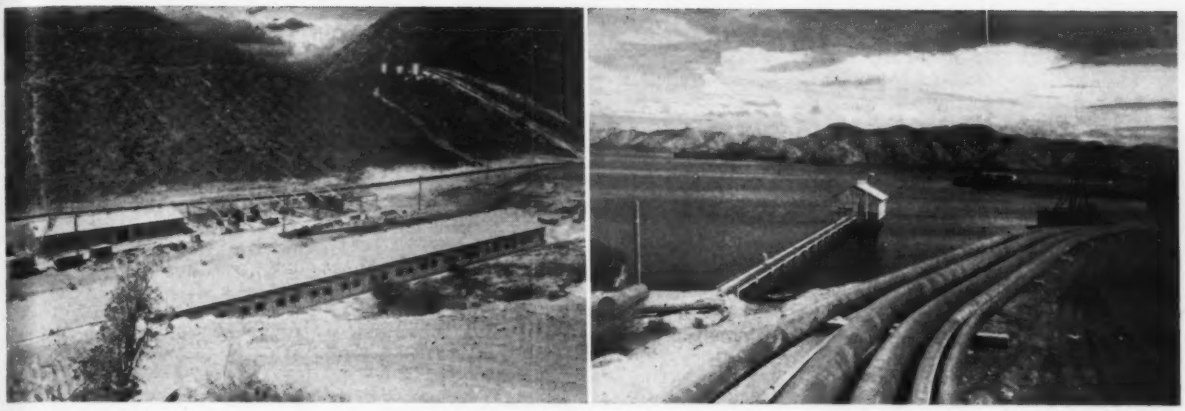
Completion of the facilities will bring total Venezuelan refining capacity to nearly 300,000 bbl. daily. Of this, some 165,000 bbl. daily has been added since the end of the war. Also located at Puerto La Cruz is the plant of Venezuelan Gulf Refining Co. with a capacity of 30,000 bbl. daily which went on stream last April.

The site of the new Sinclair refinery is adjacent to the crude-oil loading terminal which the company has operated since August 1943 on Chaure Bay slightly east of Puerto La Cruz and west of Guanta. A 100-mile pipe line of 50,000-bbl. daily capacity extends south to Santa Barbara field and through connections to other eastern Venezuela producing areas. This system will supply the full requirements of the refinery and the remaining capacity will be used for continued crude shipments.

Existing facilities in this sheltered harbor provide about 45 ft. of water depth for tanker dock loading. Four

One of the new staff houses built in connection with the refinery.

The photograph at left shows refinery process units and boiler and power house, with preparations under way for erecting the stack. Photograph at right shows the three-basin waste-water system and the A.P.I. separator.



Warehouse of the new refinery appears in left photograph. To the rear in the picture is the change house, and the shop building is shown under construction to the right. Photograph at right shows salt-water intake and pump house. The pipe lines are those leading to the loading dock.

new lines, one each for gasoline, kerosine, distillates, and heavy fuel oil, have been laid from the refinery-products tankage to the dock.

Started in 1949.—Construction of the new Sinclair refinery was started in the spring of 1949. Frederick Snare & Co., New York, had the general refinery contract. Chicago Bridge & Iron erected the tankage, and the Sinclair organization built the housing with the assistance of local contractors.

Material for the project was received over the government docks at Guanta. Peak construction force was reached in April and May of this year when more than 1,000 men were employed. The permanent operating force for the refinery and terminal will number more than 200.

Principal installations at the refinery consist of a modern topping still, treating plant, tankage, auxiliaries such as power and water systems, and housing and related facilities. The general layout and arrangement of the plant allows for the installation of additional units in the future. The still, with a capacity of 35,000-bbl. daily, will use crude of about 33° gravity from the Santa Barbara area. It includes heater, flash tower, fractionating column, and stripping tower.

To serve the refinery's production of distillate fractions, a lead-sulfide treating plant has been constructed along with the usual caustic neutralization facilities. The refinery laboratory provides equipment for complete testing and engine-rating work. The refinery also has an ethylizing plant of conventional type.

A total of 1,500,000 bbl. of new tankage has been built as a part of the refinery project. This consists of nine tanks of 150,000 bbl. each and others of smaller size. Together with the nine 80,000-bbl. tanks previously located in connection with the terminal, Sinclair now has an aggregate of more than 2,100,000-bbl. tankage at Puerto La Cruz.

Waste-water treatment.—One feature at the refinery which is of particular interest from an operating standpoint is the arrangement for handling waste water. Three earthen basins were built in a natural ravine adjacent to the refinery area. The first or ballast pit of 587,000 cu. ft. capacity is 26 ft. above sea level; the second, a separation basin, of 265,000 cu. ft., is 13 ft. lower; the third 330,000 cu. ft. guard basin, is at sea level.

In the operation of this system for pollution control, ship's ballast is discharged into the first basin where it is subject to settling and skimming. The discharge from this basin and also the used refinery cooling water goes into the second or separation basin. From this, the water passes through an A.P.I separator to the guard basin where it can, if necessary, be further settled and skimmed before discharge into the bay. The refinery sanitary sewers are served by a separate system with septic tanks.

The Neveri River supplies fresh water for the refinery. Two 500 g.p.m. pumps are located at the river, and a 9-mile, 6-in. pipe line connects the refinery. A 30,000-bbl. fresh-water supply tank provides for refinery and housing needs. The boiler feed is treated in a Zeolite plant.

Cooling water from the bay is brought to the refinery through a pump house built on piles above the 30-ft. submerged contour. It has four diesel-driven pumps of 3,500 g.p.m. capacity each.

The steam-generation facilities comprise four 600-hp. units each providing 36,000 lb. of steam per hour at 175 psi. Two 2,000-bbl. tanks are used to store the oil fuel. The power house has three turbo-generators, two of 750 kw. and one of 600 kw. In addition, the power house includes pumps for the fire-protection system.

Other buildings.—Besides the laboratory and power house, other buildings include a one-story administration and office building, change house, garage, machine shop, a 350 by 50-ft. warehouse, a carpenter-shop building, and two pump houses for loading and transferring oil.

For the use of refinery personnel, there is a 55 by 35-ft. air-conditioned infirmary with beds for four patients. This infirmary will serve as an auxiliary to the larger hospital which Sinclair has in the Santa Barbara area.

Sinclair previously had 54 houses, including 14 for staff members, to accommodate the Puerto La Cruz terminal force. To this have been added 60 houses for the refinery work force and 24 other staff houses for supervisory employes.

The refinery construction was under the direction of W. S. Gullette of the Sinclair organization. E. T. Lincoln, formerly superintendent of the Santa Barbara field repressuring plant, will be superintendent of the refinery. Assistant superintendent will be J. E. House, formerly operating foreman at Sinclair's Fort Worth refinery.

A close-up view of process units at the refinery.

Midget Crackers Ordered

Independent Italian refining company orders smallest T.C.C. units for installation at Genoa, Rome plants

TWO of the smallest-sized Thermofor catalytic cracking units yet to be constructed—with daily capacities of 1,630 bbl.—have been contracted for installation in plants of an independent Italian refining company, Permolio, S. P. A., Raffinerie Italiane Olii Minerali.

The Milan firm will use the new units as part of an over-all expansion and improvement of its facilities. They will be constructed at the Genoa and Rome refineries, where at present the company has topping facilities only, with capacities of about 2,500 and 1,700 bbl. daily, respectively.

Foster Wheeler Corp. has been given the contract for design and supervision of construction of the projects. G. Caldana, chief engineer of Permolio, has been in New York for several months arranging for the refinery improvements.

About 75 per cent Middle East crude is run in the four small Italian refineries which Permolio operates. The decision to build the small cracking units came after lengthy study of ways to improve the quality and yield of the company's production. The Economic Cooperation Adminstration, which is providing $1,534,000 for the entire program, including new lubricating-oil facilities at the Milan refinery, also had its technicians examine the company's problems.

When the cracking units are in operation, Permolio expects to reduce its fuel-oil output from the present 40 per cent to 10 per cent and possibly less. The plan of operation of each of the two cracking units calls for charging 1,050 bbl. per stream day of fresh feed. In addition, 950 bbl. will be charged to an existing topping unit.

The 315-bbl. bottoms from the topping operation will be added to the fresh feed for a total charge of 1,365 bbl. From this, 155 bbl. of heavy bottoms will be dropped out. Recycle is planned at 420 bbl., thus giving the total charge to the catalytic unit of 1,630 bbl.

The company hopes to begin construction on the units in the next 8 or 9 months with completion probable by the end of 1951. The dollar ECA funds will be used for technical assistance, royalties, and essential materials which cannot be purchased in Europe.

Other facilities planned. — Permolio's program also includes virtually complete new lubricating-oil facilities at Milan. This refinery now has a topping capacity of about 2,500 bbl. daily, a small-scale grease plant, and conventional acid and clay-treating equipment. It uses Venezuelan and some Louisiana oil, including semi-finished stock.

Plans provide for adding propane deasphalting, furfural extraction, and M.E.K. dewaxing in order to obtain quality lubricants from Middle East crude. Capacity of the treating facilities will be expanded as required by the new units. The company expects to be able to produce all grades of lubricants except insulating oil. This work at Milan also has been contracted to Foster Wheeler for design and construction supervision.

Besides the Milan, Rome, and Genoa refineries which it owns, Permolio also operates another topping plant of about 1,000 bbl. daily at Fiorenzuola, near Piacenza in the Po Valley. This plant belongs to Petroli d'Italia.

Permolio first entered the Italian refining field in 1925 with the grease plant at Milan. The company, which is entirely Italian owned, markets only lubricating oil under its own name and disposes of its other production through distributors. It produces considerable road and blown asphalt from all three of its own refineries.

Expanding coastal terminals. — The company has three coastal terminals for crude oil, and work to expand the capacity of two of these is now in progress. The Fiumicino terminal, near Rome, serves the Rome refinery. Its present capacity of about 140,000 bbl. is now being enlarged to about 175,000 bbl.

The other two terminals are in the Genoa area. One of these, existing before the war, has a storage capacity of about 105,000 bbl. At the second Genoa terminal, some 125,000 bbl. capacity has been built, and another 95,000 bbl. is to be erected. A pipeline connection of about 2½ miles is being built between these two installations.

ECA Promotes Bransky

WASHINGTON.—A shakeup in the petroleum branch of the Economic Cooperation Administration reportedly will promote present acting director Oscar E. Bransky to a post in Paris in the Office of the Special Representative, and bring to Washington as his successor Harvey W. Daniels who retired from Socony-Vacuum Oil Co., Inc., some time ago after more than 30 years of service.

Dr. Bransky will head up the petroleum section, with which considerable difficulty has been experienced during the past 2 years because of the fact that men assigned to the post have served only a few months before stepping into other jobs. Because of this Bransky himself has been going to Europe frequently to straighten out situations which have arisen.

Daniels spent most of his service with Socony-Vacuum in Japan and the Far East, where he was general manager of the company's operations in the area.

Refinery Projects

ECA funds allocated for plants in France, Italy

WASHINGTON.—Three new refinery projects in Europe have been approved by the Economic Cooperation Administration, which will contribute $5,225,000 in Marshall-plan funds toward their $48,775,000 estimated cost.

Largest of the projects is the rebuilding and modernization of the Societe Generale des Huiles de Petrole (S.G.H.P.) refinery at Dunkirk, France, virtually destroyed during the war. The reconstruction will also include installation of a crude topping unit at a refinery at Courchelettes, about 60 miles inland, which was the only equipment to survive war damage. When completed, the refinery is expected to process about 28,000 bbl. daily of crude, which will be about 9,000 bbl. more than was handled prewar by both the Dunkirk and Courchelettes refineries.

The Dunkirk project will cost $38,105,000, toward which ECA will contribute $4,005,000. Operating on Middle East crude, it will produce lubricating oils and asphalts as well as gasoline, kerosine, diesel oil, and fuel oils for sale in the French market, including French overseas territories.

A second project covers the construction of a new refinery at Lingen, near the new Emsland oil fields in Northwest Germany, by Gewerkschaft Erdoel-Raffinerie Emsland at a cost of $8,670,000, of which $670,000 will be in Marshall-plan funds. The refinery is the only completely new oil plant in the federal republic involving ECA dollar financing, and is being constructed because there are no existing facilities near the Emsland fields and the unusually high wax content of Emsland crude makes it difficult and costly to pump long distances.

To take 2 years.—Construction of the plant will take about 2 years and an output of 600,000 tons a year is anticipated, including 318,000 tons of gasoline and 72,000 tons of diesel oil

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for the domestic market, and 102,000 tons of coke for export to other Marshal-plan countries.

The third project calls for the installation of cracking equipment in the Industria Raffinazione Olii Minerali (I.R.O.M.) refinery at Porto Marghera, Italy, at a cost of $2,000,000 toward which ECA will provide $550,000. This is to be part of a modernization program announced last November to cost $6,400,000, toward which ECA approved Marshall-plan dollar financing of $1,800,000. It was included because of a determination that a greater amount of cracking will be necessary than was originally anticipated in order to improve the quality of gasoline.

The new reforming unit will have a capacity of about 4,000 bbl. daily against existing capacity of 1,500 bbl.

NEAR EAST

Egyptian Stalemate

Parliament to convene in November; hopes rise that legal barriers to oil exploration will be removed

DEVELOPMENTS in Egypt over the last few months have given rise to hopes that the Parliament at its session this winter will remove legal barriers which have virtually halted continued exploration for oil in that country.

The two companies concerned are Socony-Vacuum Oil Co., Inc., and Anglo-Egyptian Oilfields, Ltd. (Shell). They have waited for favorable action by the government for nearly 2½ years.

The new Egyptian Parliament meets November 18 unless sooner convened by the king. At the time of its adjournment in August, Egyptian officials were working on legislation to revise objectionable features of the 1948 mining law, especially the provision requiring that only 51 per cent Egyptian companies can hold producing leases.

In addition, legislation also was being prepared which would grant Anglo-Egyptian a producing lease on the Ras Matarma block on terms much the same as the older areas of Ras Gharib, Asl, and Sudr. The prospecting license under which the Ras Matarma production was found provided that the lease be under these terms, but the government has failed to take definite action on the company's application which has been on file since November 1948.

Early in August it became known in Cairo that the companies were planning to lay off approximately 1,000 workers since the continued lack of suitable legislation was forcing them to confine their operations almost wholly to development of the producing lease areas which had been confirmed earlier.

Subsequently, the companies disclosed these layoff plans would be held in abeyance, and it is understood that the government gave new assurances that the situation would be cleared up in the near future. Efforts to mediate the outstanding differences are being made by Saba Habashy Pasha, a well-known Egyptian attorney and a former commerce minister.

Requirements listed.—In their negotiations with Mohammed Ghannam Bey, the present minister of commerce, the companies several months ago listed the major requirements, settlement of which would permit them to return to full-scale field work. These were: revision of certain provisions of the 1948 mining law, confirmation of the Ras Matarma lease on the agreed terms, a price for oil in Egypt in line with that prevailing in world markets, and assurances against government penetration into the sphere of private oil operations.

The issue of price arises out of the fact that the level of government-controlled prices of products on the Egyptian market depresses the netback on crude production to an unprofitable point. Some products must be imported to meet Egyptian requirements, and these are necessarily obtained at world prices. Unlike many other countries that encourage domestic production by allowing it a relatively high price, Egypt has been holding the return on its own output at a virtually uneconomic level. Administrative action within the government itself to correct this situation is anticipated in the near future.

To expand refinery.—The Egyptian Government is moving forward with its plans for a major expansion of its refinery at Suez. Early this month Dr. Mahmud Abu Zeid Bey, director-general of the mines administration, said $2,500,000 had been earmarked for the project. The Lummus Co. received contract for the work some time ago.

Present capacity of the refinery is about 6,000 bbl. daily. When the new units are completed, total capacity will be approximately 26,000 bbl. daily. Total crude supply at present available to the government from royalty and under its 20 per cent purchase options with the companies amounts to 18,000 to 20,000 bbl. daily.

Anglo-Egyptian and Socony-Vacuum jointly produce approximately 25,000 bbl. daily from Asl and Sudr, two Sinai Peninsula fields discovered since the war. Anglo-Egyptian itself has about 20,000 bbl. daily production from its older fields west of the Gulf of Suez.

Several weeks ago, the companies received prospecting licenses on a number of unexplored blocks, but actual work on any of these awaits favorable action on the legal situation by the government. Pending a change in this, the final exploratory operation being conducted is in the Nebwi block. In this area, Nebwi 7 was recently reported at about 4,400 ft. and near total depth without production.

MIDDLE EAST

Aramco Output Sets Record

Crude-oil production by Arabian American Oil Co. in Saudi Arabia reached another new all-time high in August with 585,831 bbl. daily.

The month's daily average represented an increase of 23,191 bbl. daily over the previous record in June. The August output also was 27,258 bbl. daily greater than that reported for July.

Aramco's current high production rate is partially accounted for by the fact that the company is producing about 35,000 bbl. daily additional to fill the trans-Arabian pipe line. Crews from the two ends of the line are expected to meet sometime late this month, and the first crude delivered by the end of the year.

Besides this production for the pipe-line fill, the company's output also reflects the record high production of oil now taking place worldwide as a result of unexpectedly heavy demand. Settlement of some currency problems also has improved Aramco's position.

With the August record, Aramco's production for the first 8 months of this year averages 510,313 bbl. daily. Crude processed in the refinery at Ras Tanura during August amounted to 90,048 bbl. daily, giving daily average runs for the first 8 months of 88,234 bbl.

AUSTRALIA

Australia Aids Syndicate

Further efforts to find commercial production are being made in central Queensland in Australia's Great Artesian basin.

A report from Melbourne said geological surveys in the Longreach district are to be made by a new Australian syndicate with federal and state backing. The work is expected to be followed by seismograph surveys.

Intermittent attempts to find oil in this area have been made over the last half century.

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J. R. EIFFE

H. G. MANGELSDORF

Esso Standard Shifts Refiners

J. R. Eiffe and H. G. Mangelsdorf to take up new duties under company's rotational-assignment program

IN keeping with Esso Standard Oil Co.'s rotational-assignment program, J. R. Eiffe, general superintendent of the Bayway refinery, Linden, N. J., has been assigned to the Baton Rouge refinery, and H. G. Mangelsdorf, who has been assistant general manager at Baton Rouge, has assumed the responsibilities of general superintendent at Bayway.

Eiffe, who has been general superintendent at Bayway since 1946, joined the company as a student engineer in 1924, after graduation from Massachusetts Institute of Technology with a master's degree in chemical engineering. He has served as supervisor of the hydro plant, technical assistant to the general superintendent, technical assistant to the New Herset Works manager, assistant general superintendent, and process superintendent.

Mangelsdorf, who joined the company in 1934, was named assistant general manager at Baton Rouge last year. A graduate of Kansas State College in 1930, he took his master's degree in fuel and gas engineering from M.I.T. in 1932. He joined the company as combustion engineer and subsequently held the positions of assistant head of the Technical division, coordinator of refinery-construction projects, manager of the Chemical-Products department, and general superintendent of the Petroleum-Products division. Prior to his actual appointment as assistant general manager at Baton Rouge, he served in that capacity on a training assignment.

Charles Leet, head of the technical division of Esso Standard Oil Co.'s refinery at Baton Rouge, has been named assistant general manager, succeeding **H. F. Mangelsdorf** who has been named general superintendent of the company's Bayway refinery, Linden, N. J. Other changes at Baton Rouge include: **Dr. F. A. L. Holloway,** head of the petroleum technical-service department, named to replace Leet as head of the technical division; **Dr. R. K. Dix,** head of the chemical technical-service department, named head of petroleum-technical service replacing Holloway; and **N. C. Dunn,** petroleum technical-service section head, named to replace Dix as head of chemical-technical service. Leet went to Baton Rouge as a chemical engineer in 1931, and was named head of the technical division in 1946. Holloway joined the refinery as process engineer in 1939 and was named head of petroleum-technical service last January. Dix joined Esso as a member of the chemical technical-service department in 1943, and was named head of the department in 1948. Dunn joined the refinery as process engineer in 1941, serving in that department as group head for several years before going to petroleum-technical service.

Henry L. O'Brien has been appointed general counsel for Cities Service Co. and its subsidiaries.

H. E. Ward, North Texas district geologist at Wichita Falls, Tex., for Mid-Continent Petroleum Corp., has been transferred to Midland, Tex., as division geologist of the Texas and New Mexico area. **Wichita Fay Sheldon,** former consulting geologist for Shell Oil Co., succeeds Ward in Wichita Falls.

James R. Nolan, production engineer for Pan American Production Co. at Port Barre, La., has been transferred to Snyder, Tex., in the same capacity.

Dan R. Harris, Lone Star Gas Co., has been named plant superintendent of the company's new compressor station at Abilene, Tex. He formerly served as superintendent of the plant at Ibex, Tex., which is now inactive. Other changes in the company include: **S. A. Mitchell,** manager of the Seymour, Tex., district, transferred to Terrell, Tex., in the same capacity, succeeding **B. B. Stringfellow,** who will retire October 1; **Andrew Carter Haley,** Brownwood, Tex., chief clerk, transferred to Seymour as manager replacing Mitchell; **Lloyd F. Diggs,** transferred from Purcell to Antlers, Okla., as subdistrict manager; and **Chester R. Rogers,** superintendent of the East Texas district gasoline department, has been named assistant superintendent of gasoline plants.

Fred Haburlee, geologist for Standard Oil Co. of Texas at Houston, has been transferred to Amarillo, Tex., in the same capacity.

Wally Lumb, Phillips Petroleum Co. geologist at Amarillo, has been named representative of the Texas Panhandle district of American Association of Petroleum Geologists.

Howard Chamlee, head of geological work for **G. E. Hall,** independent oil operator, has been transferred to Midland, Tex., from Denver.

Richard F. Lemon, petroleum engineer for Stanolind Oil & Gas Co., has been transferred from Wink to Midland, Tex., in the same capacity.

John L. Ferguson, senior geologist and coordinator of the geophysical and geological department of Amerada Petroleum Corp., has joined Deep Rock Oil Corp. as vice president in charge of exploration, succeeding **Wesley G. Gish,** who resigned several months ago to enter private consulting business. Ferguson has been with Amerada for 27 years.

PERSONALS

John A. P. Ohman, formerly vice president of Geovision, Inc., and chief engineer for Rieber Research Laboratory, New York City, has been appointed a senior research engineer in the physics department of Southwest Research Institute, San Antonio. Ohman, author of various reports on petroleum-exploration methods, has directed many electronic-research projects in oil-field and industrial instruments.

H. K. McKinnon, district superintendent, and **F. Falcon,** senior engineer for Shell Oil Co., have been transferred from McCamey to Midland, Tex.

Walter Kalteyer, assistant district engineer at Kingsville, Tex., for Humble Oil & Refining Co., has been transferred to the southwest Texas division office at Corpus Christi as division equipment engineer.

R. T. Watson, British American Oil Co., Ltd., has been appointed in charge of operations at the Calgary, Alta., Canada, refinery. He joined the company 30 years ago, and was assistant manager at the Calgary and Moose Jaw refineries prior to his transfer to eastern Canada in 1944. He succeeds **M. T. Stevens,** who is now in charge of construction operations at the new Edmonton, Alta., refinery.

J. Murray Williams has been named general manager of Atlantic Refining Co.'s foreign producing activities, succeeding **C. H. Ford** who transferred to the domestic crude-oil production department at Dallas. For the past several years Williams has been managing the producing operations in Venezuela, with headquarters in Caracas.

Earl Baldridge, president of Baldridge & King, Inc., McAllen, Tex., has been elected a director of the Chicago Corp.

Richard A. Wiley, geologist, Amerada Petroleum Corp., has been transferred from Houston to Fafayette, La., in that capacity.

Frederick E. Frey, assistant director of research for Phillips Petroleum Co., Bartlesville, Okla., has been named chairman-elect of the Petroleum Division, American Chemical Society, succeeding **B. H. Shoemaker** of Standard Oil Co. of Indiana. Frey, who in 1947 was selected by the Chicago section of A.C.S. as one of the 10 outstanding petroleum chemists in the United States, joined Phillips as a research chemist in 1927.

Frank C. Fahnestock, Socony-Vacuum Oil Co., Inc., technical advisor to the chief engineer of the refinery-engineering division, has been named coordinator of foreign refining in the company's manufacturing department at New York. **R. R. Jackson,** manager of the Paulsboro, N. J., refinery, and **S. D. Dalton,** manager of the refinery-engineering division at Paulsboro, have been named to the company's manufacturing committee in New York City. Jackson will be succeeded at Paulsboro by **E. L. Sinclair,** assistant manager, and Dalton will continue as manager also of the refinery-engineering division.

R. R. JACKSON

S. D. DALTON

R. L. Sprague, Delta district exploitation engineer for Shell Oil Co., has been transferred to the New Orleans area office as reservoir engineer. Other transfers include: **A. A. Lamb,** production foreman, from Gibson to West Lake Verret, La.; **C. C. Herring,**

PLAN FIELD CONFERENCES.—Representatives of the drilling industry and educational institutions met in Dallas recently to discuss plans for a series of field conferences on personnel problems in the drilling business. The conferences will be sponsored by the American Association of Oilwell Drilling Contractors and the University of Texas. Seated, left to right: Pete Dublin, Donnell Drilling Co., Midland, Tex.; Mickey Bell, W. H. Black Drilling Co., Midland; Charles Cyrus, University of Texas; M. L. Powers, Oklahoma A. & M. College, Stillwater, Okla.; A. Q. Sartain, Southern Methodist University; Forrest Smith, Carl B. King Drilling Co., Midland; and Luther Bailey, University of Texas. Standing, left to right: Jim Conway, University of Texas; Harry Halsell, M. J. Delaney Co., Odessa, Tex.; R. L. Dailey, John Woodruff, Gordon Oliver, Vernon Bruce, and Jack Wiggins, all of University of Texas' petroleum-extension-training staff; A. L. Franzolino, Southern Methodist University; G. W. Hutcheson, George P. Livermore, Inc., Lubbock, Tex.; John Carpenter, Kerr-McGee Oil Industries, Inc., Oklahoma City; Jim Brown, Westlund Drilling Co., Midland; Burt Riesley, University of Texas; Harry Woodward, Thompson-Carr, Inc., Houston; and W. H. Herndon, Western Co., Midland. Others attending the 4-day conference, but not included in the photograph were George P. Livermore, Lubbock; Claude Pipes, Texas Employers Insurance Association, Dallas; J. Doyle Settle, A.A.O.D.C., Dallas; and Earl Bowler, University of Texas.

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PERSONALS

production foreman, from West Lake Verret to Gibson; **R. L. Brown,** junior geophysicist, from Houston to New Orleans as geophysicist; **N. E. Duval, Jr.,** junior geophysicist, from Houston to Lake Charles as seismologist; and **M. J. Prucha, Jr.,** junior geophysicist, from Houston to Seismic Party 45 as seismologist.

Duncan M. Smith, Jr., The California Co., petroleum engineer specializing in offshore drilling operations at Bay Marchand field, Golden Meadow, La., has resigned and returned to Louisiana State University, Baton Rouge, for further studies.

M. R. Shaffer, office manager and executive assistant in the production division of Cities Service Oil Co. at Bartlesville, Okla., has resigned to enter petroleum consulting work at Tulsa. He joined the company in 1939 as petroleum engineer.

J. H. Galloway, district superintendent of the California district for Humble Oil & Refining Co., has been named assistant division superintendent of the West Texas division. Other changes include: **John S. Bell,** East Texas division petroleum engineer, named to succeed Galloway; **Harry Pistole,** Gulf Coast division assistant petroleum engineer, named to succeed Bell; **Fred N. Wise** named to succeed Pistole; **W. W. Holland,** tool pusher, transferred from the Eucutta district, Louisiana division, to the Winters district, North Texas division; and **M. H. Buchanan,** district transportation foreman, Galveston Bay district, Gulf Coast division, transferred to the Snyder district, West Texas division.

H. M. Shearin, Jr., engineer in the production department of Humble Oil & Refining Co., has been transferred from Friendswood, Tex., to the Houston production-research division.

D. L. Norling, formerly an instructor in petroleum geology at Ohio State University, has opened offices in Tulsa as a consulting geologist. He formerly served 7 years with Shell Oil Co., and 3 years with Devonian Oil Co.

N. C. Simpson, formerly assistant to the production supervisor of the Fort Worth division of Gulf Oil Corp., has been transferred to Houston as general assistant to **B. G. Martin,** assistant to the vice president in charge of production operations.

W. E. Best, production superintendent for George P. Livermore, Inc., Lubbock, Tex., has been transferred to Pauls Valley, Okla., as consulting petroleum engineer.

Bruce E. Williams, formerly field engineer for Anchor Gasoline Corp. at Eola, La., has joined Canal Refining Co. as refinery superintendent at Church Point, La.

Narvin B. Frickman, associate petroleum engineer for Humble Oil & Refining Co., has been transferred from Avoca to Winters, Tex., in the same capacity.

Kenneth E. Meyer, production engineer for Cities Service Oil Co., has been transferred from Houston to Fort Worth in the same capacity.

H. J. Gruy, formerly with DeGolyer & MacNaughton, petroleum consultants in Dallas, has opened offices in Fort Worth as a consulting geologist. He previously was with Shell Oil Co. and Standard Oil Co. of Texas, and is a graduate of Texas A. & M. College.

Frazier M. Stewart, Stanolind Oil & Gas Co. district engineer in the Big Horn Basin, Lander district, Cody, Wyo., has been transferred to Tulsa as assistant reservoir-engineering supervisor.

William H. Smith, Jr., formerly engineer with Carter Oil Co. at Carmi, Ill., has joined Barron Kidd Oil Co., at Evansville, Ind., as assistant development of production superintendent.

J. W. FOLEY

James W. Foley, assistant to the vice president of The Texas Co., New York City, has been named assistant to the chairman of the board, succeeding **James H. Pipkin** who has been named general manager of industrial and public relations. Foley, a 1932 Texas A. & M. College graduate in petroleum engineering, joined Texaco after graduation as a rotary rig helper. He served in Bahrein and in various producing-department positions in the Southwest before his transfer to New York last year.

George V. Holton, chairman of the board, Socony-Vacuum Oil Co., Inc., has been named vice chairman of the New York convention committee for the thirty-seventh National Foreign Trade Convention to open there October 30.

Henry Gwaltney, in charge of operations for Eidson & Gwaltney Drilling Co., Inc., has been transferred from Fairfield, Ill., to Washington, Ind., in the same capacity.

J. M. Volkmann, representative of Trans-Arabian Pipe Line Co. at Dhahran, Saudi Arabia, is on a tour of the United States, during which he is stopping at Tulsa, Birmingham, and Houston, for the purpose of interviewing pump-station personnel for employment in Saudi Arabia.

DEATHS

Mrs. Norman M. Hancock, 63, who founded Omega Oil Co. in 1930, died September 13 in San Antonio. She was vice president of the Dixie Oil Co. from 1918 to 1928.

W. B. Hawkins, 54, drilling superintendent for Callery & Hurt Drilling Co., died in an airplane crash September 14 at Lubbock, Tex.

Lloyd C. Morris, administrative head of the chemicals branch, of the research and development department of Phillips Petroleum Co., died August 1 in Bartlesville, Okla.

John R. Gordon, 49, chief engineer for Lion Oil Co., died September 17 in El Dorado, Ark.

G. A. C. Halff, 70, president of Blanco and Bluehawk Oil Companies, died September 11 in San Antonio.

R. W. Sexson, 64, operating manager for the White Eagle division of Socony-Vacuum Oil Co., Inc., died August 10 in Omaha. He joined the company in 1918 at Wichita.

George Dewitt Robinson, independent oil operator formerly associated with Bay Petroleum Corp., died September 8.

W. H. Walthall, Sr., 68, formerly with Lone Star Gas Co. before his retirement, died August 6 in Fort Worth.

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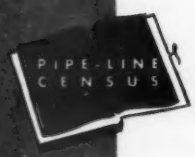
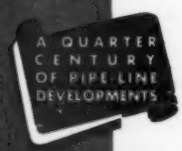
THE PIPE-LINE INDUSTRY



Pipe-line contractors have been and are building more pipe lines than at any other time in the history of the industry. Yet the thriving pipe-line-contracting business has never had "figures" on itself, as an individual segment of the oil and gas industry. A "Pipe Liners' Census" is now available. Several months ago the Journal created a special field organization to compile this. All pipe-line contractors were contacted. The census is presented in this issue, showing . . . who they are . . . where they are . . . their home offices . . . manpower in the industry . . . number of spreads available and operating, other information.



Pipe-line engineering in 25 years' time has opened up a new era in pipe-line design, construction, and operation. About 25 years ago, technically, the industry was just beginning to change. In 1925, for example, screw-coupled lines were still common practice. But large plans were brewing. The pipe-line industry has come a long way since then. It has grown from crude empirical designs to efficient, economical layouts. The new 1950 projects are flexible, and function largely under automatic control. Construction speeds have been increased, costs cut. An editorial report in this section outlines significantly, "A Quarter Century of Pipe-Line Developments."

Highlight information is presented on "How to Build a Complete Pipe-Line System," as a special feature in this issue. Many individual phases and separate items which go into pipe-line engineering-construction have been detailed before. Now all of the important "know how" steps have been collected and published in one place. This step-by-step treatment, it is felt, will make interesting reading for anyone dealing with oil and gas. In the way the Journal has assembled the information, via many special drawings and charts, the "How to Build" subject breaks into 11 distinctive pipe-line-construction steps.

Each annual Pipe Line Number features a variety of specially written engineering-construction articles by leading authorities. This issue contains an outstanding list of such material. Some articles are on crude-oil lines, some on products-pipe-line systems, while others are devoted to natural-gas-transportation projects. Articles on specific engineering details are also included, such as welding, river crossings, compressor-station designs, remote gaging, new radio communication systems, and so forth. Among the articles is the Journal's pipe-line editor's account of Middle East pipe-line-construction work.

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A Census of Pipe-Line Construction Contractors

BY THE OIL AND GAS JOURNAL

THIS CENSUS of pipe-line contractors in the United States is an original and unique undertaking by The Oil and Gas Journal. Such a project has never been undertaken before.

Sure! A pipe-line contractor is a firm that builds pipe lines. But that is a mere skeleton definition and doesn't mean anything. A penetrating and detailed census, firm by firm, can turn the spotlight in true focus on this important segment of the oil and gas industry—and this is what the Journal has done in its "Census of Pipe-Line Contractors" presented on these pages in summary form.

Census Data

Complete information on all United States pipe-line contracting firms in this census project is made to show ... who they are ... where they are ... their home offices ... manpower in the industry ... number of spreads operated in: (1) big-inch construction; (2) little-inch construction; (3) trunk-line construction; (4) lateral-line construction. These data cover the manpower and equipment figures for pipe-line contractors only; spreads operated by oil and gas pipe-line operating companies are extra.

Census Procedure

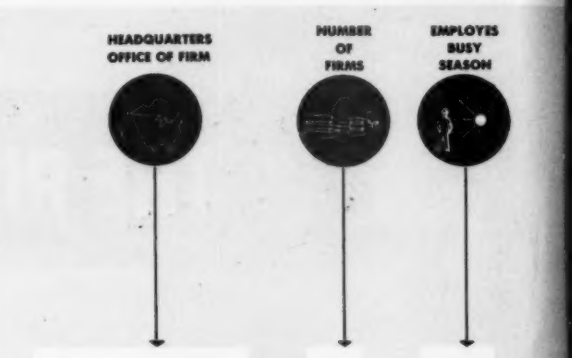
Several months were required for the special field organization created by the Journal to compile this census. During the time interval, various pipe-line spread equipment was going into service, and the work of other spreads was being completed. Hence the total manpower employed by contractors necessarily was grouped into two bases: (1) busy season, and (2) slack season.

To make this census, Journal men traveled by car, train, and plane. They talked personally with both the larger and the smaller contractors and obtained fullest cooperation from those actually operating pipe-line construction equipment.

Census Results

The pipe-line contracting survey and census, as to the final results just compiled, may first be condensed into a recapitulation of total manpower and firms as follows:

Total U. S. employes during busy season, for all contractors	64,402
Total U. S. employes during slack season, for all contractors	9,874
Total number pipe-line contracting firms operating in the United States	142



HOUSTON; GULF COAST	26	15,250
WEST TEXAS	15	5,520
DALLAS-FORT WORTH	6	5,670
OTHER TEXAS	12	2,080
TULSA	17	8,265
OKLAHOMA CITY	8	3,820
OTHER OKLAHOMA	4	2,165
SAN FRANCISCO	5	5,100
LOS ANGELES	11	3,850
MIDDLE WEST*	11	3,565
KANSAS	10	2,167
EASTERN†	7	2,435
OTHER UNITED STATES‡	10	4,515
TOTALS	142	64,402

*Includes Michigan, Illinois, Indiana, Ohio, Kentucky, and Tennessee.

†Located in Pittsburgh; Washington, Pa.; Philadelphia (2); Harrisburg; Camp Hill, Pa.; New York City.

Survey of Equipment

Pipe lines are constructed in a great many different sizes, whether they are used for crude oil, products, or natural-gas service. Much of the equipment necessary to construct the larger pipe lines must be in greater numbers and of heavier and greater sizes, so some arbitrary classification of equipment is necessary. Incidentally, in pipe-line construction termi-

EQUIPMENT DATA, UNITED STATES TOTALS

Number of pipe-line contractor firms	142
Maximum spreads possible in any one classification:	
Big-inch spreads	158
Trunk spreads	341
Gathering-line spreads	482
Number of spreads now operating:	
Big-inch spreads	112
Trunk spreads	147
Gathering-line spreads	166

DIRECTORY OF CONSTRUCTORS

A complete listing of all pipe line construction firms showing ...

- **Management personnel**
- **Complete address**
- **Headquarters city**

appears in this issue of the Journal ... turn to page 350.

LIST OF CONSTRUCTION PROJECTS

A complete listing of all pipe-line-construction projects—oil, products, gas; domestic and foreign—starts on page 362.

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nology, the many items of equipment that must be operated to construct a pipe line or segment thereof are grouped totally under the over-all or collective designation "Pipe Line Spread."

Equipment in a pipe-line spread includes ground-clearing equipment; rooters; plows; trenchers; tractors and bulldozers; automotive and truck equipment; lineup clamps; welding units; pipe-bending equipment; sidebooms and cradles; pipe cleaning, priming, wrapping, and coating machines; portable dope kettles, and a host of other special items and machines unique to the industry.

Investment Costs in Spread Equipment

In this census a big-inch spread is defined as complete equipment for pipe-line construction of 16-in. and above. The total investment in a complete big-inch spread may amount to as much as $750,000.

A trunk-line spread is for 6 to 15-in. The cost of a trunk-line spread, all told, can aggregate $500,000, plus or minus.

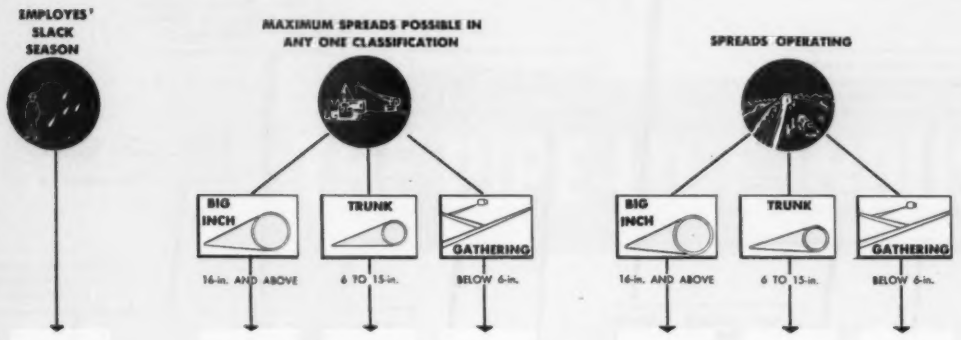
A gathering line or lateral spread is for lines below 6-in. Investment of a gathering or lateral-line spread runs up to as much as $100,000.

Special Construction Activities

The straightforward construction of pipe lines, whether for crude oil, products, or natural gas, is the single largest individual phase of pipe-line contracting work. However, pipe lines themselves are not operative without the design and installation of a great number of special facilities, pumping and compressor equipment, storage installations, etc.

The Journal's Census of Pipe-Line Contracting Companies found that the number of firms which could handle special pipe-line equipment and installation facilities is quite large. The number of firms which possess manpower and equipment to make the various special installations is totaled as follows:

Pumping and compressor stations	31
Reconditioning of lines	69
Major river crossings	49
Pipe stringing	36
Trenching and back filling	64
Wrapping and coating	58
Welding sections	64
Radio communications	6
Telephone and telegraph	11
Tank-farm lines	45
Storage tanks	12
Marine terminals	11
Right-of-way clearance	51
Cathodic protection	37



2,170	34	60	65	25	21	7
403	13	37	46	6	10	13
455	15	19	12	12	4	0
179	9	20	16	9	5	4
877	25	46	48	17	25	0
548	6	18	21	4	10	8
212	4	11	10	4	1	3
1,330	10	19	**35	7	16	**16
2,120	10	31	**150	2	23	**100
299	11	21	25	9	6	4
65	3	14	16	3	8	4
360	8	21	13	8	3	0
836	10	24	25	6	15	7
9,874	158	341	482	112	147	166

‡Contracting firms for pipe-line construction also are headquartered at other points throughout the United States as follows: Hobbs, N. M.; Farmington, N. M.; Cape Girardeau, Mo. (2); St. Louis; Kansas City, Mo.; Baton Rouge, La.; Harvey, La.; Lance Creek, Wyo.; and Huntington, W. Va.

**In California pipe-line-construction operations this item is designated as "crews," instead of "spreads," for this class of work.

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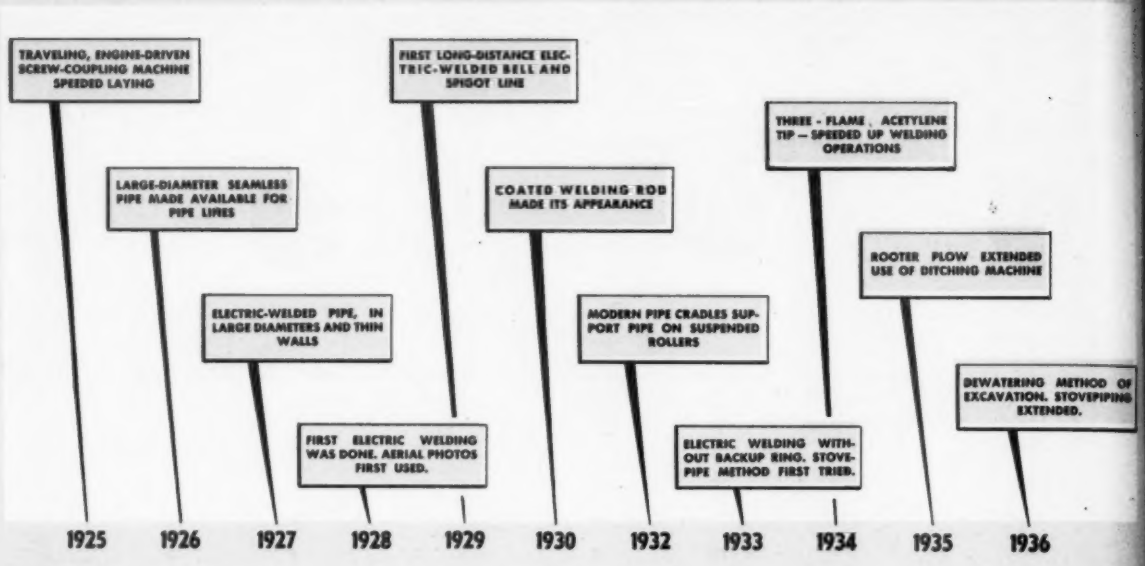
TRAVELING, ENGINE-DRIVEN SCREW-COUPLING MACHINE SPEEDED LAYING
LARGE-DIAMETER SEAMLESS PIPE MADE AVAILABLE FOR PIPE LINES
ELECTRIC-WELDED PIPE, IN LARGE DIAMETERS AND THIN WALLS
FIRST ELECTRIC WELDING WAS DONE. AERIAL PHOTOS FIRST USED.
FIRST LONG-DISTANCE ELECTRIC-WELDED BELL AND SPIGOT LINE
COATED WELDING ROD MADE ITS APPEARANCE
MODERN PIPE CRADLES SUPPORT PIPE ON SUSPENDED ROLLERS
ELECTRIC WELDING WITHOUT BACKUP RING. STOVEPIPE METHOD FIRST TRIED.
THREE-FLAME ACETYLENE TIP — SPEEDED UP WELDING OPERATIONS
ROOTER FLOW EXTENDED USE OF DITCHING MACHINE
DEWATERING METHOD OF EXCAVATION. STOVEPIPING EXTENDED.
1925
1926
1927
1928
1929
1930
1932
1933
1934
1935
1936

Quarter-Century Of Pipe-Line Developments

A whole new era in pipe lining was initiated, to a very marked degree, some 25 years ago. Technically, the industry was just beginning to change. In 1925 screw-coupled lines were still the predominant practice (the traveling, engine-driven screw-coupling machines had made their appearance, were used to speed up pipe-line laying).

But large plans were brewing. Pipe-line operators were commencing to visualize a far larger and more extensive network of systems. The pipe-line industry began to search, study, and inaugurate with positive action (as never before) with respect to these factors: Market research data, additional consumers, increased demand for petroleum products, new outlets—and an ever-increasing spread of territory where oil and gas was being discovered, developed, and produced. From a technical standpoint, new methods and equipment were soon to stream forth to meet and assist the forthcoming heavy construction program—which was to be on a large and dynamic scale.

IN 25 YEARS' TIME, PIPE-LINE ENGINEERING HAS . . . . .

- **Grown from rough, rule-of-thumb designs to efficient, economical layouts of systems; flexible, and functioning largely under automatic control.**
- **Construction practices revolutionized; speed increased, costs cut.**
- **Results have been huge expansion, with networks of new systems spreading to all important consuming areas.**
- **Shown on these pages are a number of the significant engineering advances during 1925-1950.**

1926—Large-diameter seamless pipe was first made available for pipe lines.

1927—Electric welded pipe appeared in large diameters and with thin walls, for use on pipe lines.

1928—First electric welding was done on a short oil line into Corsicana, Tex., using bare rod. The type of joint was bell and spigot.

Aerial photographs used in pipe-line location. The first known use of this method was employed on a pipe line from Yates pool to Port Arthur, Tex.

1929—Electric welding with bell-and-spigot pipe joint was tried on a long-distance oil line into Chicago. The experience of this line was not satisfactory as it had 45 breaks in the electric welds the first year.

1930—Coated electric welding rod made its appearance and was used experimentally on 32 miles of 20-in. gas line in Kansas. Acetylene welding for pipe joints by a new method began placed in widespread use.

Product pipe lines had their great starting point in 1930. Plans were announced for the joint venture of six Mid-Continent refiners to form Great Lakes Pipe Line Co.—and build a 1,240-mile gasoline pipe line from Oklahoma and Kansas to the heavy consuming areas around Kansas City, Omaha, Des Moines, and the Great Lakes area. Tuscarora Oil Co., Ltd., started pumping its first tender of motor gasolines from Bayway, N. J., to Midland, Pa., 370 pipe-line miles away. Phillips Pipe Line Co. commenced construction of a 735-mile gasoline line from its Borger, Tex., refinery to Kansas City and St. Louis. All told, in the year 1930 the refined-products pipeline industry was operating 1,289 miles of line, and 18 pump stations were in use. (First pipe-line move-

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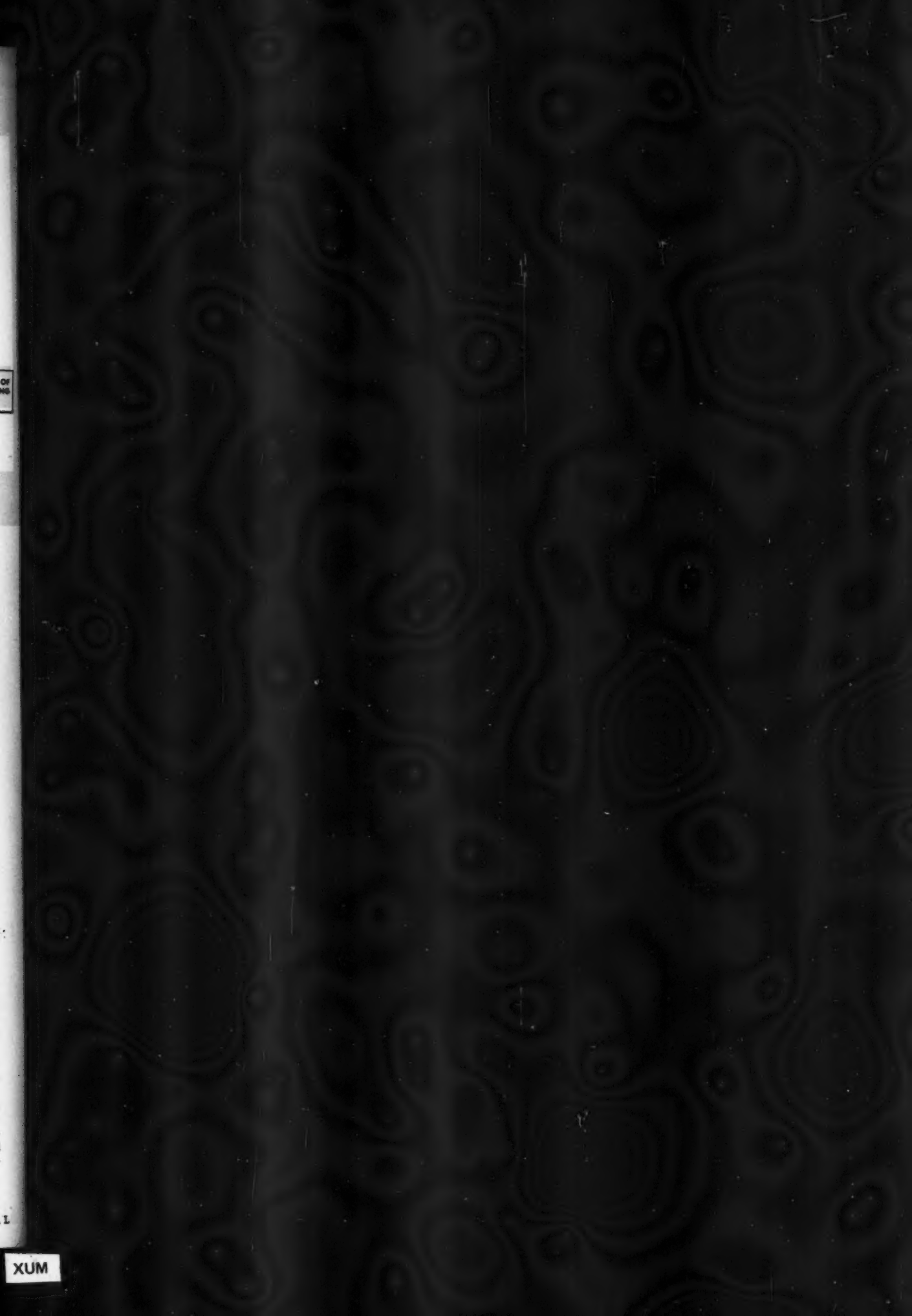

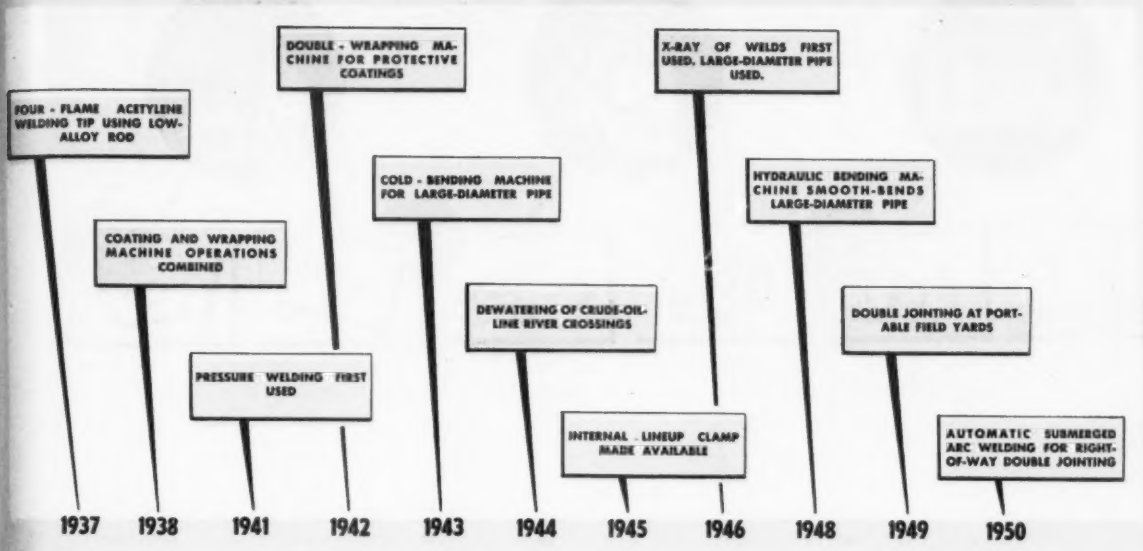

ment of refined products started in 1901, when United States Pipe Line Co. started use of a 4-in. line between Titusville and Marcus Hook, Pa., batching three grades of kerosine.)

1932—Priming attachment developed for direct installation and use on cleaning machine. Modern pipe cradles were introduced for supporting pipe on suspended rollers.

1933—Electric welded joint used, without a backup ring. Stove-pipe method of pipe-line construction employed on a line near Turnertown, Tex., pointing the way to present technique of "stove piping."

1934—Three-flame oxyacetylene tip speeded up welding with acetylene comparable to that employing the electric arc.

1935—The rooter plow extended utility of the ditching machine into areas previously requiring blasting.

1936—Dewatering method of excavation for river crossings first used on a gas pipe line in western Kansas.

Use of the stove-pipe method extended in pipe-line construction. Used on 49 miles of 10-in. in eastern Kansas and 93 miles of 12-in. in West Virginia, this year.

1937—Four-flame oxyacetylene tip for "position" welding, using low-alloy rod. Six-flame oxyacetylene tip for "rolling" weld also made available this year.

1938—Coating-and-wrapping machine operations were combined to function together in a single engine-driven unit.

1941—Pressure welding first used on 2 miles of 6⅝-in. pipe line near Tucson, Ariz.

1942—Double-coat, double-wrap machine for protective coatings on pipe lines first used on an 8-10-in. crude line built to Port Arthur, Tex.

1943—Cold-bending machine for large-diameter pipe developed and used on part of the 24-ft. war-emergency crude line and all of the 20-in. products line.

1944—Dewatering of crude-oil pipe-line river crossing used on a 16-in. crude-oil line from West Texas to Oklahoma.

1945—Internal lineup clamp made available for use in the pipe-line industry.

1946—X-ray of welds first used on an 18-in. pipe line in California.

Large-diameter pipe made available for pipe-line construction by the submerged electric-arc process. This was for a California 30-in. gas line.

1948—Hydraulic bending machine developed capable of making smooth bends in large-diameter thin-wall pipe.

1949—Double jointing at portable field yards, using automatic submerged arc welding preceded by manually applied stringer beads.

Hard fiber board applied as substitute for soft earth padding in pipe-line trenches.

Products pipe-line systems reached total of 20,109 miles, and 325 pumping stations were in use.

1950—Automatic submerged arc welding on 100 per cent basis experimentally developed for double jointing on right-of-way itself.

ACCOMPANYING THIS ISSUE ARE TWO SPECIAL WALL MAPS . . . .

Crude Oil; Products Pipe Lines:

A completely new "Journal-Guide" multicolor map, for all systems. Refinery locations and crude-oil capacities are included.

Natural-Gas Pipe Lines:

Up-to-date "Journal-Guide" map showing all carriers; capacities of principal systems are tabulated. Producing gas fields are outlined.

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11 STEPS . . in Pipe-Line Construction

STEP 1

TRANSPORTATION ANALYSIS, AERIAL PHOTOGRAPHY, GROUND SURVEYING . .

These pages show "How to Build a Complete Pipe-Line System," step by step. Many of the individual phases have been detailed before. But here the Journal presents, for the first time, highlights of the complete undertaking from start to finish.

Transportation analysis.—This is the first and a very large step in pipe-line construction. The analysis is the phase which both initiates, and finally establishes, every pipe-line undertaking. In this step the oil or gas company reaches its decision as to the needs for the new pipe-line project. Determination is made as to where the pipe line will originate and where it will terminate. The minimum, average, and maximum load demands are calculated. The service to be rendered to industry and consumers is ascertained.

For new crude-oil pipe lines, studies of oil reserves, rate of development, and sustained producing capacity must be made for the "input" area to the line. Similar studies are necessary as to refinery demands, for the "output" area of the proposed project. In products-pipe-line planning, similar studies are made of the "contributing" sources (refineries) at point of origination, of the demand for products by consumers at intermediate taps and the terminus. In natural-gas pipe-line projects, detailed analyses of gas reserves are made at the one end, and the present and potential gas demand by industry and domestic consumers at the other. Primary engineering and market studies are a very important part of this "analysis" phase.

The "supply and demand" data next must be translated into terms of "engineering sizes and facilities." This phase definitely places the project into a pipe line (1) of an approximate length, (2) of certain pipe diameters, and (3) with a given number of pumping or compressing stations. However, planning at this stage nearly always is channeled into a number of selected alternate plans. The planning may have two or more alternative layouts, and engineering design may incorporate several alternative systems as to pipe sizes, pressure gradients, and other desirable possibilities.

Cost studies of each alternative preliminary plan follow. Similar calculations are made to estimate the financial earnings for each plan. Finally, comparisons are made of the construction costs for each plan versus the estimated earnings. The comparisons are used to select the layout plan, design, and specifications which the owner will use for the new project.

Aerial photography.—In the early planning for a large project, aerial surveys and the science of photogrammetry are new and important tools. They save much time and ground survey-crew expense. They yield detailed data on the route or routes within a few weeks.

Reconnaissance flights are normally the first step in the early planning stages. Here the pipe-line owners, engineers, and pipe-line contractors fly the general route to obtain preliminary views. Detail route

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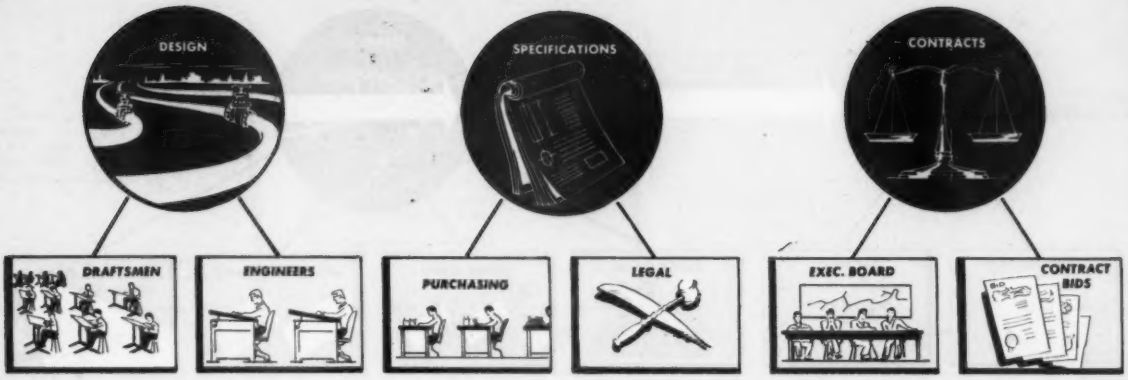

photography is employed later. Then the science of photogrammetry, including the preparation and determination of contour data, is applied.

Surveying.—Detailed ground surveying also is done, using transit and leveling instruments. Special profiling equipment may be used in some instances for reconnaissance and topographical work.

The above estimates, calculations, and details are involved in the planning for the 9,000 miles of pipe-line construction now under way or proposed in the United States and abroad. Similar work in general has been applied in the building of the pipe-line transportation systems already established in the United States, totaling as follows: Crude-oil lines, 16,200 miles; products lines, 22,400 miles; natural gas-lines, 254,300 miles.

STEP 2

DESIGN, SPECIFICATIONS, BIDS

Pipe-line design.—In this step are required thousands of estimates and design calculations. Design and installation drawings may be prepared in the hundreds. All must be checked and rechecked, affirmed, and approved. Load volumes and pressure gradients are calculated. Pipe-line design as related to actual construction operations includes data, studies, design, and drawings which involve right-of-way clearing; stringing pipe; ditching; possibly crossings of rivers and streams; bends and loops; welding methods; how the line will be cleaned, primed, coated and wrapped; and the methods to be employed in various tests.

Design details also incorporate lowering-in and backfilling operations and how the right-of-way will be finally restored in cleanup operations. Designs and drawings must be prepared showing all details for the construction of the pump or compressor stations. The pipe-line facilities and services should be examined as to possible protection from corrosion. They may also include details on telephone or telegraph, and radio communication systems; storage facilities, including tank farms, terminals, and marine installations.

Writing specifications.—A heavy chore at this point is the translation of the detailed data on the design of the pipe-line project, into "specifications." The specifications must be complete and without possibility of misunderstanding as to intent.

Engineering, administrative, and legal talent are combined in preparing adequate specifications which permit the pipe-line contractor to calculate labor, material, and other related costs, together with the time required to complete construction. The aforegoing applies to specifications for pipe-line construction; however, other specifications are prepared especially for many items of machinery and equipment.

Considering bids.—Specifications for the pipe-line project are reproduced in multiple units, usually bound together in booklet form. These are distributed to the pipe-line contractors for their studies and bid making preparations. Performance bonds are required from the contractors bidding on the project; also, insurance and indemnity guarantees.

Services offered to the oil and gas company by the pipe-line-contracting industry are complete and extensive. Some pipe-line contractors maintain organizations which are set up to handle the installation of complete systems, including design, construction, and the turning over to the owner of the completed project, ready for operation. Other pipe-line-contracting organizations, both large and small, are specialists.

Some pipe-line-contractor specialists devote their work to pipe stringing only. And others specialize in pipe laying, coating, radiography (X-rays and gamma rays) of welding operations. Similarly, other contractors install mostly pump and compressor stations, while others work on cathodic protection. Still other firms specialize in telephone or telegraph or radio communication work. Construction of tank farms, terminals, and marine installations involves large construction fields in themselves. Many contractors can handle several specialized types of work.

When the successful bidders have been awarded contracts, work begins, either immediately or in a few weeks, and here the pipe-line contractors, operating either turnkey or as specialists, cooperate very

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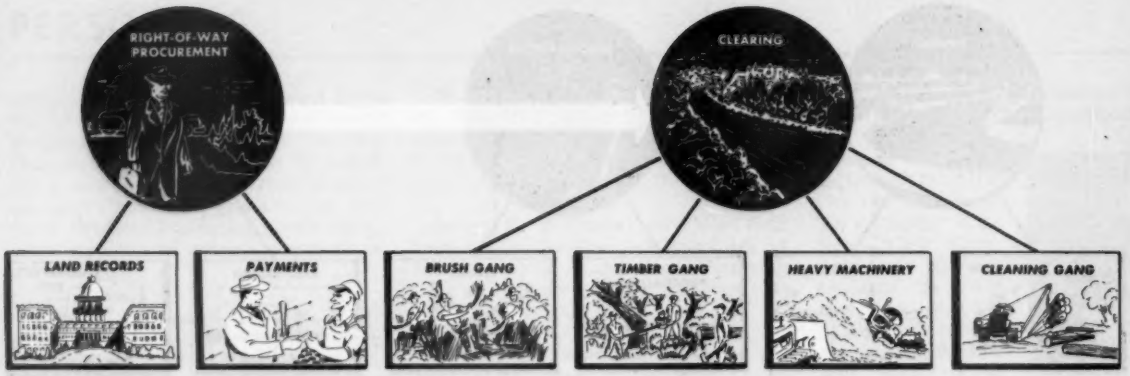

This is "plan view" of pipe-line route, before construction begins

Clearing commences, trees and all other obstacles are rapidly removed

closely with the contractee. The contractee or oil and gas company uses members of its own organization as inspectors. Pipe-line inspectors work in the field with the pipe-line contractors. Continuous inspections and daily reports are made. The status of the construction work is recapitulated daily, weekly, and monthly.

Progress of the work often very quickly reaches an interesting "competitive" status, because of the custom of dividing long lines into sections, for laying by different contractors. Progress of the different pipe-line contractors may be compared in carrying on the job. Competitively, there are two viewpoints in pipe-line construction, and one might be summarized as "haste makes waste" while the other could be termed "time is money." Each of these construction aspects has advantages under certain conditions of construction and necessity.

STEP 3

OBTAIN RIGHT-OF-WAY, CLEARING

Right-of-way easements.—These are obtained by the oil and gas or pipe-line company. The company's organization must have detailed maps from its engineering departments which show the exact route to be followed by the line. Names and addresses of individual landowners are obtained from public records and abstracting firms.

Suitable lease forms granting right-of-way easements are prepared and the landowners' names and addresses inserted on the forms. These are given to the grantees' agents, who on large-line projects may be extremely numerous. The agents make an effort quickly to obtain the necessary signatures and acknowledgments.

Usual payments for easements may be $1 per rod, more or less, and the easement may be for a width varying from 30 to 100 ft. In cases where the landowner does not "sign up," legal action may be instigated, using the particular state laws under the rights of "eminent domain." In conditions of extreme necessity, however, the line route may be diverted to avoid delay and cost of court action.

Clearing right-of-way.—Clearing equipment for right-of-way includes bulldozers, gasoline-powered tree saws of both circular and chain-tooth types, mobile units, fence gangs to cut fences and make gates, and the tried and long-proven brush gangs with axes and cross-cut saws.

Purpose of this step is to put the ground in shape for the passage of vehicles necessary for construction work—stringing, ditching, cleaning-priming and coating-wrapping machinery, backfills, etc. The ground must be smooth enough for the passage of both heavy equipment and lighter construction units, including automobiles and jeeps.

If pipe lines were always to traverse such favorable territory as the flat plains of the Southwest, and the land itself consisted of only large ranches with few fences, clearing pipe-line right-of-ways would be a far easier matter than it usually is. However, the surface conditions involved in the majority of long lines vary tremendously: mountains, valleys, swamps, forests, and with surface and subsurface soil that will include ordinary dirt, solid rock, shale, caliche. And the temperature changes during an extended period of construction may vary from plus 100° F. in summer to far subzero weather in winter.

Clearing or preparing right-of-way in highly improved suburban areas and in municipalities is usually a trying operation for the contractor. Although the pipe-line company normally obtains the necessary easements for installing the pipe line and the specifications take into account the liability on general damage to property, the contractor may often find himself in any number of relatively minor but annoying circumstances with property owners and tenants. Ultimately such problems are ironed out satisfactorily but some temporary agreement must be obtained by the contractor's agents without delaying construction progress.

The establishment of good relationship with property owners and tenants on and adjacent to the pipeline route is of prime interest to the pipe-line company. Consequently the contractor and company combine their efforts generally to maintain that objective.

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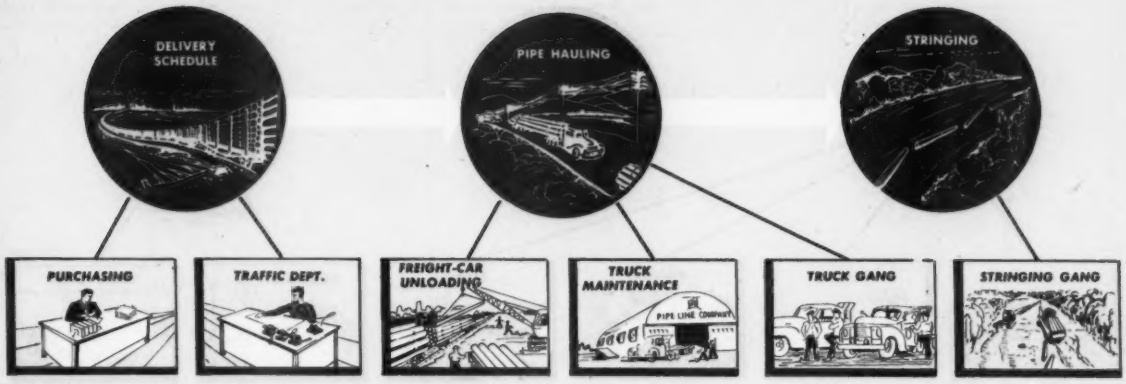

STEP 4

PIPE HANDLING AND STRINGING

The manufacture, shipping, handling, and stringing of pipe for a big construction project are spectacular operations to the casual observer. But these steps are vital to the success of the project. To the pipeline contractor efficient pipe stringing is one of the vital logistics of pipe-line contracting because subsequent construction operations cannot start until the "pipe is strung." It can be added that every phase of pipe lining is logistical, and that in one sense the whole business is successfully built on the basis of having the proper manpower, enough equipment, and sufficient materials all at the right places at the right times.

Pipe stringing, specifically, is the transportation and laying down of the pipe joints alongside the pipe-trench route. Logistically, however, pipe stringing is closely tied in with (1) operations of the pipe mills producing the pipe and (2) transportation from the steel mills to railroad pipe yards along the pipeline route.

Steel requirements for a long-distance big-inch construction project are such that a pipe mill must operate continuously on that order alone for several weeks or months. Railroads moving this pipe out to the pipe-line route may handle an entire trainload of pipe every few days, sometimes even daily. Good coordination, trafficwise, is needed in the proper spotting and handling of the pipe at the different railroad unloading points.

The pipe-stringing contractor's job usually begins at the railroad unloading sidings. For any given railroad unloading point, the stringing contractor may have to truck out and string the pipe along a wide arc of territory covering 10 to 50 or more miles.

The pipe is unloaded directly by hoists from the railroad cars to the stringer's truck trailers. The contractor then "strings" the pipe as his trucks make their trips to the pipe-line right-of-way.

Pipe-line contractors customarily follow a regular procedure of operations, in construction. The pipe stringing is always done on the right-hand side of the trench location, when looking in the direction of progress of the pipe line spread. This is because the ditching machines throw backfill to the left side of the trench. The pipe joints are strung with their ends overlapping, so that sufficient pipe is available to account for material out for bends, pipe rejections, damaged ends, etc. After stringing the pipe, the joints are arranged in staggered positions for convenience of pipe gang tractors. Obviously, all service equipment, including welding units, priming, coating and wrapping machinery, holiday inspection service, etc., are operated on the right-hand side of the right-of-way.

STEP 5

DITCHINGS, CROSSINGS

The vast majority of all pipe-line systems are trenched and installed underground for the following reasons: (1) agricultural usage of the surface; (2) prevention of tampering and to remove line from potential vandalism, "curiosity seekers," etc.; (3) to smooth out temperature variations troublesome in surface installations; (4) to permit access and full movement across the land surface of a pipe-line route.

Principal types of equipment involved in trenching are wheel-type ditchers, rock drills, backhoes, and draglines. Equipment used in trenching depends on nature of both surface and subsurface conditions. Where the terrain is very swampy, draglines will be employed. For earthy soils, clay, sand, and soft formations, wheel-type ditchers are used exclusively. In rocky terrain, pneumatic drills bore holes for blasting of the trench.

Ditching machines are sometimes preceded by "rooters" to tear up the upper portions of the trench. This makes for easier subsequent work. Ditching operations sometimes are run on a 24-hour basis. Other operations of the pipe-line spread or spreads are performed "daylight."

In pipe-line ditching, the following table exhibits

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Ditching begins

Roads and river crossings prepared

average trench dimensions for different sizes of pipe lines:

EXAMPLES OF DITCH DIMENSIONS
(Two large crude companies, one natural-gas company)

	Width of ditch, in.		
	Crude		Natural gas in earth and rock
Pipe dia., in.	In earth	In rock	
8	20	24	..
10	24	28	22
12	28	32	24
14	30	34	26
16	32	36	28
18	36	40	30
20	40	44	32
22	42	48	34
24	42	52	36
26	..	..	38
30	..	..	42

Note: Crude-oil lines generally use 20 to 24 in. for earth cover, 12 to 18 in. in rock; natural-gas lines, 30-in. cover for earth and 24 in. in rock.

Crossings.—Construction work involving crossings is very common. On land, it involves boring and even tunneling underneath highways and railroads. As to water locations, pipe lines are constructed to go under rivers, lakes, bays, and other bodies of water. Special pipe-line bridges or crossings are also built over creeks, bayous, and rivers.

At crossings under highways and railroads, most state laws require installing the pipe in casing of larger diameter which is remotely vented. In rivers and harbors, pipe lines are buried deep below the bottom where it is necessary to avoid damage from floods, anchors of boats, and dredging activities. At many inland rivers, shallow installations in river beds are common. River clamps or the newly developed integral concrete pipe encasements are generally necessary in this work except where thick-wall pipe is sufficiently heavy to hold it down.

Some of the crossings now being and only recently installed in navigable waters are extensive projects within themselves. Some ingenious engineering methods have been put to use in designing and building many subsurface river and water crossings. The skills required in the various phases of constructing under-water crossings range far wider than those involved in other construction projects.

STEP 6

BENDING OPERATIONS

The shortest distance between two points, according to geometry books, is a straight line. But in pipeline construction to an important degree the optimum distance not always is the shortest distance. The most desirable and practical distances may involve curves, bends, and gradual arcs—all arising from problems in topography and the procurement of right-of-way. Soil conditions, locations of cities, villages and industrial structures, and other factors may also enter.

Pipe-bending operations are almost altogether done in the field. Pipe-bending methods include bending by use of portable hydraulic or mechanical pipe-bending units, or employment of a pipe-bending shoe installed on the side of a boom tractor.

In contrast to the field fabrication of pipe-line bends, the manifolds and valve piping at blockoff-valve locations, pump and compressor-station locations often are prefabricated in shops, thence shipped to the location of valving and manifolding installations.

Cold bending of pipe having a wall thickness relatively small in ratio to its diameter, requires considerable "know how," particularly when the pipe is of large diameter in the "thin wall" class. The controlling factors relative to bending methods used are numerous. Among them are degree of curvature per unit length, surface conditions of the pipe after final bending, effect on physical properties of the pipe, and dimensional changes in wall thickness and diameter.

Depending primarily on the commodity to be transported along with other factors peculiar to a given pipe-line system, a designer may often specify one or more of the current pipe-bending methods to be used in building the pipe line. Where conditions do not lend themselves to shoe-and-side-boom-tractor bending, "wrinkle" or "smooth" bends are employed as dictated by specifications.

Wrinkle bending resolves into a series of uniformly shaped flutes formed in the pipe walls. These flutes are approximately semicircular in cross-sec-

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Pipe bending Manifolds Station construction

tion, resembling corrugated metal roofing and siding. Pipe dimensions and relative location and number of the wrinkles, primarily determine the degree of curvature for a given bend.

Smooth bends, today, are made with little if any detrimental change in cross-sectional dimensions of the pipe. In fact, current methods improve to some degree physical properties of the pipe material by cold working. The method also generally causes an increase in thickness of the pipe wall. Some out-of-roundness of the pipe may result under certain conditions when this method is used but this is not generally considered to be of serious nature.

STEP 7

WELDING, PIPE-GANG OPERATIONS

One of the greatest improvements in pipe lining has been the widespread developments in welding, and techniques and procedures for better and faster welds. It was only 20 to 25 years ago that screw-coupled lines began going out of existence, and the first all-welded lines appeared on the scene. Today welded pipe lines are firmly established.

The early lines were welded by both oxyacetylene and electric-arc methods; however, the latter within 10 years became the most acceptable and is in universal use today. Oxyacetylene "cutting," however, still has an important place in special pipe-line detail and reconditioning work.

In electric-arc welding the sequence of steps in pipe-line construction is (1) buffing beveled ends (joint preparation), (2) truing the ends, (3) joint alignment (operation of mechanical or electrical internal lineup units or external clamps), (4) running of beads.

In pipe-line welding, the "stringer" bead is the first one run, followed closely on many projects by a "hot pass" which deposits little weld metal but has an annealing effect by retarding the cooling of the stringer bead. It also fills pin holes. Then comes the filler and lastly the cap or cover beads. The practice of welding is now highly developed and types and sizes of electrodes and welding current are extremely important. Welders must pass rigid qualifying tests. Welding inspections include visual examinations, internal X-ray, internal gamma ray, and external X-ray. Welding coupons are prepared periodically and tested for tensile strength, soundness (nick break), and for ductility (bend test).

Stove-piping is a common procedure in welding pipe lines. In essence, it consists of adding one joint at a time to the line already welded. Double jointing is a pipe-line name for the welding together of two mill joints (most mill joints are 40 to 50 ft. long). Double jointing has been particularly valuable for the 31-ft. joints produced by one mill. On double-jointing operations, any of three procedures may be used: (1) manual double jointing on the right-of-way ahead of the pipe gang, (2) double jointing in field yard, manually, with automatic units, or both, (3) experimental double jointing by automatic welding machines operated in the field immediately ahead of the pipe gangs.

Welding today is a highly efficient, economical, and satisfactory process. Tests show that a properly welded pipe-line joint is stronger than the adjacent pipe wall. This is demonstrated by the results from "pull tests" made on coupons, with the break occurring in the pipe-wall section of the coupon rather than in the welded section.

STEP 8

CLEANING AND PRIMING, COATING AND WRAPPING, TESTING

Buried pipe lines are coated and wrapped to prevent the ravages of corrosion. Exhaustive experimental tests and years of actual experience have demonstrated that properly protected pipe lines last longer than uncoated lines, in circumstances where electrolysis and galvanic action occur. Coating and wrapping of pipe lines, therefore, is in the nature of "insurance," just as painting of houses, buildings, or automobiles insures them against deterioration.

Cleaning and priming.—The cleaning and priming

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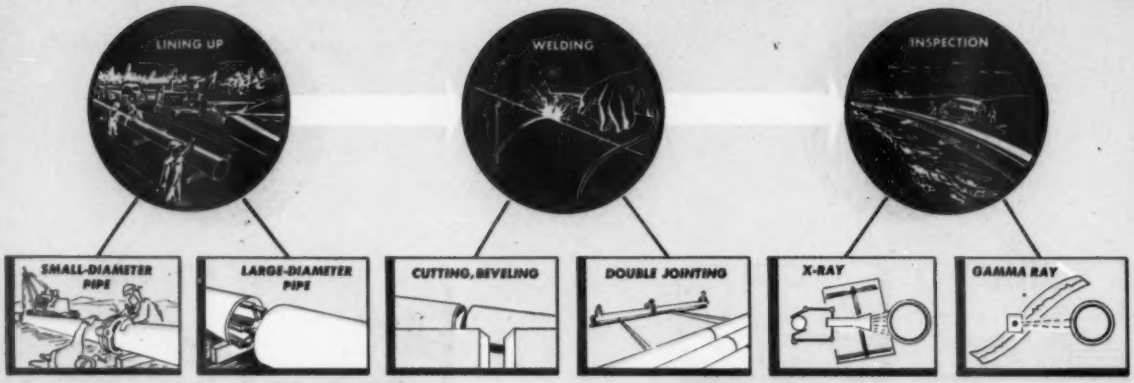

machine is a unit driven by a gasoline engine which travels along the pipe and removes dirt and rust from its outer surface. Immediately behind the cleaning section of the machine is a device for applying a thin coat of primer (to which the "hot coating" is later applied). Purpose of the primer is defeated unless the pipe is thoroughly cleaned. The priming coat is the bonding element between the pipe wall and the hot coating. The cleaning itself is accomplished via rotating wire brushes or hammers; the priming coat is applied via rotating wiping equipment.

Coating and wrapping.—Coatings are compounded from either petroleum-base or coal-tar materials. The number of coats applied varies from one to three.

The first phase of coating operations begins at the railhead or other convenient points where mobile kettles are filled with coating material. These kettles are self-heated by thermostatically controlled burners, and mechanically agitated. The kettles move along with the coating-and-wrapping engine-driven unit known as the "dope" machine which travels on the pipe. They are of between 10 and 30-bbl. capacity. A sizable number of kettles are necessary to "feed" doping operations of a normal pipe-line spread. Hot coating runs through flexible hose to the dope machine, for application to the entire surface of the pipe by flooding or spraying. Control of coating thickness and temperature is important. From spools on rotating arms, wrapping material is simultaneously applied to the hot coating.

Wrapping materials consist of asbestos felt, glass fabric, and kraft paper. Purpose of the asbestos-felt material is to prevent damage to the underlying coating in backfilling, and to protect against "soil stress" exerted against the coating under alternate wet and dry conditions. Glass fabric acts as a reinforcer in the coating itself and intermeshes with the coating while still hot. Kraft paper affords certain protection to the coating and is sometimes used to prevent dripping and wastage of the coating while still hot, and for deflecting the sun's rays while the coated pipe rests on skids. Deflection of the sun's rays is sometimes also accomplished by whitewashing where kraft paper is not used. Coating and wrapping operations formerly were separately handled. The modern developments for efficiently combining these steps into a single operating unit have made great contributions to the effectiveness of coating and wrapping materials. Pipe also is coated and wrapped in special centralized yards.

Testing.—Pipe lines are pressure tested in various ways upon final construction. Of interest in pipe-line testing is the "holiday" detection device employed to insure suitable coating and wrapping. This electric device is passed over the coated and wrapped line, usually immediately behind the actual operation. Special follow-up patching gangs take care of the holiday detection and look for open coating or holiday spots. Many of these troublesome spots are actually microscopic "pin holes," but the holiday apparatus readily locates them.

STEP 9

LOWERING IN, BACKFILLING, CLEANING UP

Many speedier and more economical developments and improvements have been made in the procedures of lowering in, backfilling, and cleaning up during recent years. These developments mostly are in the form of improved equipment.

"Cradling into the ditch" is lowering the pipe into the ditch directly behind the coating and wrapping machine. This dispenses with placing the pipe line on skids, after coating-wrapping. Ridges or mounds of soft dirt are placed at 10 to 30-ft. intervals along the trench bottom to support the pipe so that its hot enamel surface is not damaged when cradled into the ditch. In rocky ground, the pipe-line company usually specifies that the pipe be protected above, below, and on the sides by soft dirt or sand, known as "padding," or by a hard fiber board.

Backfilling operations are accomplished rapidly by bulldozing equipment. "Cleanup work" consists of removing everything off the right-of-way which was left during construction. On agricultural lands cleanup means restoring the surface of the ground approximately to what it was before pipe construction began. This involves such steps as removing large stones, burning trash, etc.

Concerning cleanup operations, the contractor's

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problems are frequently complex yet they are normally handled with a high degree of dispatch. In disposing of trash removed from the right-of-way the contractor must use caution. Where the accumulation of refuse from initial clearing operations through backfilling is to be disposed of by burning, damage to surrounding areas must be avoided. If refuse is to be disposed of by other means than burning on the right-of-way, the contractor is required to obtain a suitable location and provide transportation as well as manpower for handling and burning of the trash at the remote location. Probable damage to buildings, crops, and other property often adds to the problem of selecting sites for burning refuse at locations away from the right-of-way.

In wooded areas, merchantable timber as a rule must be trimmed and cut to suitable lengths acceptable to the lumber industry. Such timber normally is disposed of by the pipe-line company. However, the contractor is usually required to stack merchantable timber at suitable points along the right-of-way.

Another item usually included in cleanup specifications is the restoring by repairing or by other suitable means, any public property which may have been damaged as a result of pipe-line-construction operations. Normally about the only items of this nature damaged in the course of constructing the pipe-line system are bridges, culverts, and on occasion highway road surfaces.

STEP 10

PUMPING AND COMPRESSING STATIONS

A multiplicity of factors are involved in the design of a modern pipe-line station. These factors range from selection of building site, through equipment sizes and arrangement, to the layout plans for the various buildings comprising the over-all station installations. Without respect to the specific service in which a pipe-line booster station is to be operated (crude oil, products, or natural gas), all design factors relate primarily to the performance requirements and operational economics of the installation.

General location of the pumping and compressing stations is established usually in the preliminary design of the pipe-line system but its exact location may not be determined until later. Selection of the final site for the station depends primarily on:

1. **Accessibility** from public roadways and railroads and its proximity to a theoretical location as determined by the line's pressure gradient.

2. **General topography** and surface geology of the area and climate of the region such as heavy snow or excessive rainfall. Even the direction of prevailing winds in the area oftentimes enters into the selection of a station site where certain types of aerial cooling equipment are involved.

3. **Location of service company** power supply or of fuel-supply sources where the pipe line is not transporting fuel that may be used for the station's operation.

4. **Suitable water** in sufficient quantity to meet station operational requirements along with the domestic needs of the operating personnel and their families when housing is supplied nearby. On rare occasions large quantities of water may be needed for emergency uses in fire fighting, consequently this unlikely occurrence must be given consideration.

Modern pipe-line and compressing stations are as well constructed and equipped as any other types of industrial plants. Air conditioning, efficient lighting, both artificial and natural, and color schemes on building walls and ceilings provide the operating personnel of a remotely located station with all the working comfort found in large-city office buildings. In keeping with operator's quarters all other buildings and working areas are designed and built for convenience and permanency. Architecture of many of today's pipe-line pumping and compressing stations is utilitarian but not extremely "modernistic." Where dwellings are provided for operating personnel adjacent to the station proper, design and construction are also aimed toward convenience and permanency.

Equipment for compressor or pump operations varies generally with the operating company and the material being transported through the pipe line. As to main-line pumping equipment installed for handling crude oil or refinery products in new installations there has been an increasing use of cen-

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Pipe line lowered *Backfilled* *Right-of-way cleaned*

trifugal-type pumps in recent years. The bulkier reciprocating pumps in long service at older stations have demonstrated advantages of their inherent flexibility which are valuable under some conditions of crude-oil service. Reciprocating equipment is installed to a great extent in natural-gas compressing stations. One large natural-gas line now under construction is to be equipped with both reciprocating and centrifugal-type gas compressors. Two other natural-gas transmission lines have centrifugal units in their compressing equipment. The kind or type of pump or compressor chosen for a given station in any pipe line system is a matter of correlating many different factors.

The trend in petroleum and natural-gas pipe lining in the last 10 years has been toward larger-diameter pipe and wider spacing of pump and compressor stations.

The prime movers for pumping and compressing equipment for pipe-line operations may be all of one type, or a combination of different types. Factors influencing selection are economy in operation, investment cost, and maintenance. The problem of selecting a prime mover for either pumping or compressing stations is worked out with extreme care by the pipe-line designer. A decision is reached only after a large number of factor combinations have been explored in detail. The type of pumping or compressing equipment which is to be used dictates the general type of prime mover in certain instances.

Power for pumping or compressing operations is obtained normally with the following prime movers: (1) internal-combustion engines, and (2) electric motors. Steam turbines and gas turbines are comparatively recent innovations in United States pipe lining, for driving centrifugal equipment. As a general rule internal-combustion engines, either diesel, gas, or dual-fuel equipment, are employed to operate reciprocating pumps and compressors. Diesel engines drive centrifugal pumps at many stations. Likewise electric motors are used in connection with centrifugal pumping equipment. Depending on availability of cheap gas fuel, water, and other factors there are future possibilities for turbine-type prime movers in station design. The first steam turbines in American pipe lining are being installed this year by one gas line where abundance of water is available for condensing. For the past year an experimental gas-turbine installation has been studied for pipe-line possibilities.

Modern stations are equipped with a wide variety of auxiliary equipment. All of this equipment, essential to efficient operation, is selected with as much care by the station or pipe-line-system designers as are any other equipment items comprising the over-all installation. Similarly considered is the equipment employed in maintenance since it is also essential to efficient operation. In many instances maintenance operations influence appreciably the layout and arrangement of equipment in a station because the designer takes into account the importance of facilitating maintenance work.

Station piping is a very important phase of both design and construction. Proportionally, as much effort is given to the calculation and design of a station piping as is given to the main line. An example of why station-piping design is highly important is illustrated in an actual case wherein only 1 psi. pressure drop across the piping of a large gas-transmission line station is equivalent to approximately 40 hp. This portion of station design includes valves, fittings, and all other items comprising the over-all piping system.

The studies involved in equipment selection for pipe-line pumping and compressing stations are very extensive. With economy as the watchword the designer selects the equipment as dictated by the various physical factors governing the specific installation. So complex are the combinations arising from the numerous factors that the answers to the selection of an exact item of equipment may not often be clear. Where the designer is confronted with conditions which indicate no clear answer is at hand, he frequently relies on test data obtained under conditions simulating those of actual operation. Judgment based on experience plays an important part also in such cases.

Today's equipment supplier substantially relieves the designer of the burden of equipment testing in many instances. Most of the manufacturers of pumping and compressing equipment and the various auxiliaries such as prime movers, coolers, and the like maintain test laboratories in which nearly any kind of test may be made on their products.

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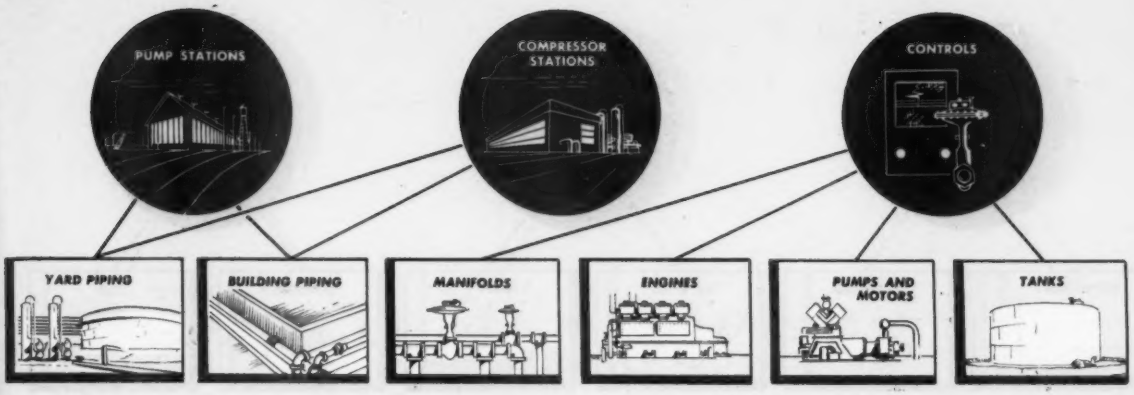

STEP 11

PIPE-LINE FACILITIES AND SERVICE

This part of the necessities for the construction and operation of a pipe line system includes in general four different divisions. Without respect to design, construction, or operational sequence these divisions are:

Communications.
Storage and terminals.
Metering and control.
Maintenance.

Communications.—To obtain efficiency in operation of a pipe-line system, all divisions connected with the movement of crude oil, products, or natural gas are closely coordinated via one or more methods of communications. Generally, wired circuits for telegraph and telephone of the older installations have been augmented or supplanted with teletype equipment in the systems where coordination of operations involves only a small number of stations and terminals. On several large new systems, ultrahigh-frequency or microwave radio and teletype equipment is being installed this year as an innovation in pipe lining. Voice communication is obtained throughout the system and often in the field with frequency-modulated (FM) radio circuits. Teletype is generally used to transmit information on gaging, metering, and other information, all of which make up the records on the systems operations.

Storage.—The trend in recent years has been toward the reduction of tankage for storage at intermediate points on pipe-line systems. Tankage is generally installed at stations to provide flexibility of operation and for emergency purposes. At certain junction and terminal points there is large tankage, sometimes amounting to several million barrels, to facilitate deliveries to shippers and for transfer to other lines. Closed systems operate without tanks at pump stations.

Storage for products pipe-line systems in general includes a wide variety of tankage and normally of less capacity than those installed in crude-oil transportation systems. In type, these tanks are similar to the tanks installed in modern refineries since they are used to store many of the same products manufactured by the refinery. The type, capacity, and number of storage tanks installed in a products pipe-line system are a function of line capacity, number and kind of products transported, the number of take-off points, and the nature of deliveries made to shipper's tanks or trucks.

Terminals.—Basically, a crude-oil or products pipe-line terminal is made up of a pumping station and a group of tanks. This general combination of station and tanks comprises either inland or water way (marine) installations. The principal difference between the two kinds of terminals is that the inland terminal makes delivery to initial consumers or receives crude oil or products via pipe line, tank car, or tank truck, or a combination of these three types of transportation, whereas the marine terminal receives from or delivers to barges, tankers, or both.

Natural-gas transmission system delivery terminals are normally designed to deliver to other systems or to serve a city-gate sale purpose. Generally they consist of a manifold composed of meters and pressure-control equipment. This manifold is connected to a pipe-line distribution system which delivers the gas to the ultimate consumer.

Terminals on the input end of a natural-gas transmission system usually are composed of compressor stations similar if not identical in layout and design with booster or intermediate stations, plus dehydration and desulfurization plants in some cases. The principal difference between a receiving or input terminal and a booster station is that the terminal station gets its incoming natural gas initially from the supply source (field or gasoline plant) whereas the booster is supplied with its incoming gas from either the receiving terminal or from another booster station.

Metering and control.—To keep account on deliveries and receipts, all pipe-line systems are provided with some type of equipment which permits suitably accurate measurements to be obtained on the incoming and outgoing material being transported. In addition to these measurements of the particular commodity, still another is required to balance accounts in the over-all system when storage tanks are involved. This particular measurement is the inven-

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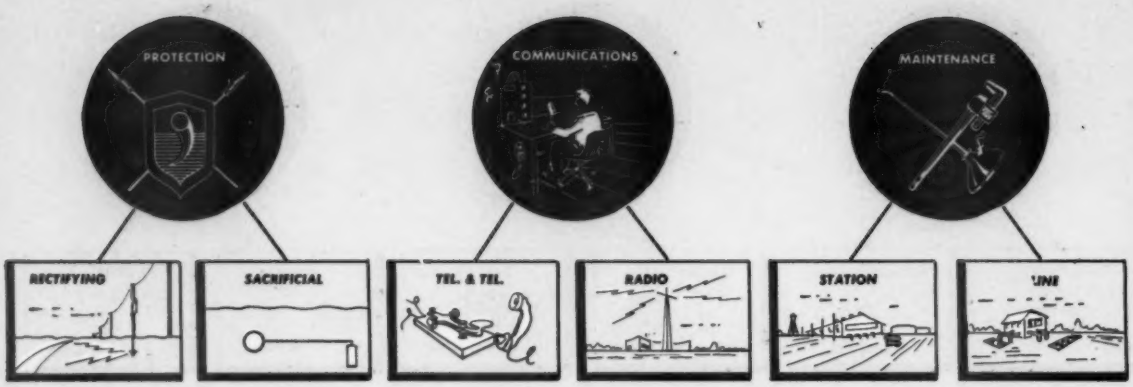

tory of all involved storage at any given time. Another accounting involving measurement is the contents of the pipe line itself, which in essence is a storage vessel.

In the case involving a natural-gas transmission system, metering is generally resolved into measuring accurately receipts and deliveries. Although not as simple as it appears, measurement operations for natural-gas transmission systems is not as complicated as those for some crude-oil and most all product pipe lines. In those crude-oil pipe-line systems where more than one type or grade of crude oil is handled and must be kept separated throughout the system, the problem of measurement becomes complicated, proportional to the number of different types handled. To some degree the problem may be modified by shipment (tender) schedules. The problem becomes even more complicated in transportation of refined products because of the wide variety and often relatively small volumes of the tenders. Petroleum measurements are made by tank gaging. Some lines are using liquid meters.

Equipment for metering natural gas either into or out of a pipe-line system generally involves high-pressure, high-capacity instruments. Normally similar metering is carried out at booster stations and where such operations are employed similar metering equipment is used. An interesting and one of the important reasons for installing metering equipment at a booster station is the measurement of the gas used in "packing" certain sections of the line so that it serves as a storage reservoir, to aid in meeting conditions of peak demand. This does away with the need for tremendous surface storage capacity at distribution points.

Maintenance.—This subject separates generally into two divisions; one includes the repair and servicing of equipment, and the other involves preventive measures aimed at reduction in frequency of if not entirely eliminating repairs. Measures for combating corrosion on pipe lines falls naturally under the heading of preventive maintenance, as does painting of buildings, machinery, and other equipment. Machinery, such as pumps, compressors, prime movers, and other items subject to mechanical deterioration through normal use, are also objects of preventive maintenance.

Corrosion mitigation as practiced in pipe-line operations of today is a very important part of the overall picture. Engineering operations in this highly specialized field begin with surveys and studies of a pipe-line system to determine which portions of the system are subjected to corrosive action and the contributing conditions. Although coatings are applied to pipe-line surfaces to a large extent to aid in retarding corrosive action from various sources, additional measures are frequently employed. Among these are sacrificial anodes commonly of magnesium or aluminum. Ultimately the anodes deteriorate to a point where they must be replaced or added to in order to be effective.

Another method for combating or mitigating corrosion of pipe lines, cathodic protection, is one which employs direct electric current transmitted through ground beds of junk iron or steel. This method, as well as that employing sacrificial anodes, produces excellent results and saves the pipe-line industry large sums of money annually.

Reconditioning of existing pipe lines is another important phase of pipe-line maintenance. Here the line, usually an old one which was placed in service without suitable coating and was operated without benefit of corrosion mitigation, is completely modernized with respect to corrosion to its exposed surface.

Generally, reconditioning work is contracted similarly to that for a new line. Whether the job is contracted or carried out by pipe-line-company crews, the equipment and procedures employed are much like those employed in new construction. The work involves removing the buried line from its trench, cleaning thoroughly its surface, patching individual holes and areas as specified, coating and wrapping, and finally lowering in and backfilling.

Various details have been worked out on the different steps in reconditioning of existing pipe lines. These details vary widely from company to company; however, specifications involving contracted work are as complete as are those on new pipe-line installations. Basically the operations on reconditioning any line are similar to those on another pipe line although there is often wide divergence in procedure and techniques. There is also variation in the types of protective coatings used in reconditioning.

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Fig. 1—Pipe line system of El Paso Natural Gas Co. and subsidiaries. Near Ehrenberg, Ariz., it connects with trunk line of Pacific Lighting Corp. affiliates transmitting to Los Angeles. Near Topock, Ariz., it will transmit to the Pacific Gas & Electric Co. line being built to San Francisco. The entire system from the Farmington, N. M., area to Topock is proposed for construction.

DESIGN AND CONSTRUCTION *of a* GAS-COMPRESSOR STATION

A step-by-step account of a compressor installation, from its inception until the completed plant goes into operation

by John F. Eichelmann

EL PASO NATURAL GAS CO., up to the present time, has built and is operating a total of 28 compressor stations, with a total horsepower of 309,770. Auxiliary horsepower has been installed to give a total generating capacity of 30,542 kva. These stations are generally subdivided into two sections—field stations and main-line transmission stations.

As may be seen from Fig. 1, the entire source of gas supply with one exception, is from reserves located in the Permian basin in West Texas. The one exception is the gas supply source in Panhandle field in Texas.

Field stations are generally designated as those concerned with multi-stage compression (two or three-stage) of the field gas to approximately 550 psig. from a suction varying from 5 to 150 psig. These field stations are usually operated in conjunction with a gasoline or a gas-treating plant.

The El Paso Natural operation is unique in that the greatest part of the gas handled is sour; that is, containing appreciable quantities of H_2S and CO_2. Gas treating is carried out almost as an independent operation, although it is an integral part of the majority of field stations. Main-line or transmission stations take the gas,

John F. Eichelmann is chief engineer for El Paso Natural Gas Co. He was born August 7, 1908, in San Luis Potosi, Mexico. Reared and educated in Mexico, he came to the United States in 1928 to work for American Smelting & Refining Co. in El Paso, Tex., as a draftsman. In 1931, Eichelmann was employed by El Paso Natural Gas Co. as a surveyor on the company's line extension to southern Arizona and Mexico. After completion of this line, he worked in succession as dispatcher, measurement engineer, and field engineer. In 1938 Eichelmann was appointed to his present position.

PIPE-LINE Section

treated and dehydrated, from the field stations, and single-stage compress it to a maximum transmission pressure of 830 psig.

This article on El Paso Natural stations is subdivided into three sections: (1) Selection of the Compressor Units, (2) Piping Design and Associated Equipment, and (3) Electrical Equipment. Field stations do not vary appreciably from transmission stations. The chief difference is in the selection of multistage compressor units and in the integration of the gas-treating plant into the plant piping system.

Selection of Compressor Units

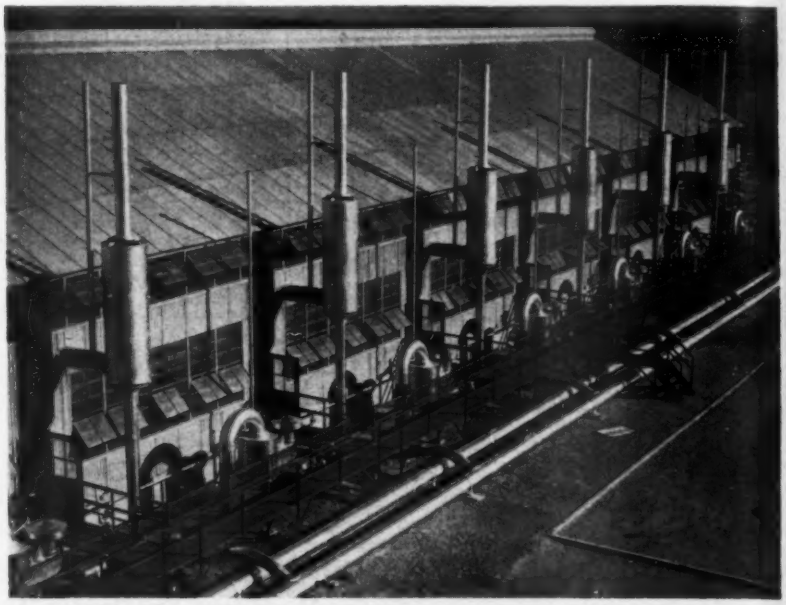
After the initial calculations have been made in regard to the station spacing over the entire line, the job of compressor selection is considerably simplified. The selection of compressor horsepower is, of course, paramount before progressing to the compressor station design. Considerable thought and engineering should accompany any decision on compressor units selected for a proposed station. Therefore, consider the factors or engineering involved in the selection of compressor horsepower.

Performance.—The selection of a compressor unit must necessarily coincide with the operating performance to be expected from the units in respect to load, company operating policy, etc. El Paso Natural follows the policy of operating its engines at rated load, rating the engines in accordance with Diesel Engine Manufacturers Association (D.E.M.A.) standards, and therefore, expects the engines to be able to carry rated load and to be loaded or unloaded to this figure over the design operating range.

In addition to the engine carrying rated load, it is felt that the unit should be capable of operating at 10 per cent over rated load for intermittent periods without excessive laboring or damage to the engine. This, in effect, is insurance on the ability of the compressor unit to carry its rated load continuously over its amortized period of 20 years or more. This is considered a reasonable demand for stationary equipment such as gas-engine-driven compressor units.

Specifications.—After the operational and design characteristics of the compressor station have been established, it is then necessary to consider the specifications for the equipment. Specifications should serve three primary purposes:

1. To inform the equipment manufacturer of the operational and design characteristics demanded of his equipment.
2. To list the engineering information necessary to the purchaser for station design and engine evaluation.
3. To set up and define any inspections or field acceptance tests which are to be considered in the contract for the compressor units.



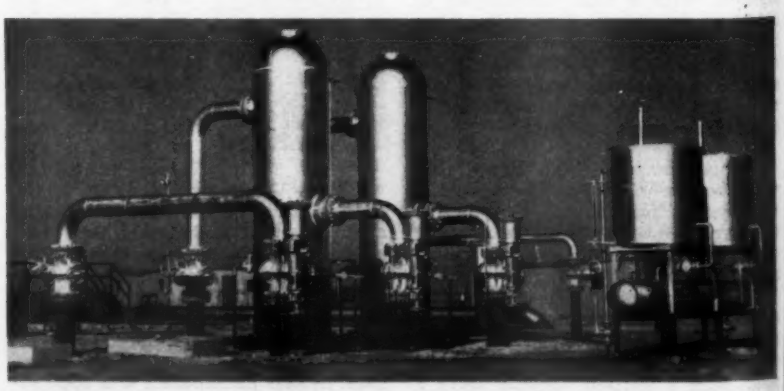
View of a compressor building showing suction and discharge piping, air cleaners and exhaust silencers.

These specifications should be flexible so that the manufacturer may be free to quote his equipment to the best advantage, but all general operating characteristics desired in the engines, such as rated load and overload characteristics, fuel guarantees, etc., should be definitely adhered to in the specifications by both manufacturer and purchaser.

Manufacturer's proposal.—The proposal submitted by the manufacturer should include all engineering information called for in the specifications. In addition, the proposal should include outline drawings showing the space dimensions of the compressor unit. The proposal submitted by the manufacturer should be required to contain all engineering information necessary, such as jacket water and lube-oil heat-rejection rates, compressor-performance curves, principal dimensions and weights, and fuel guarantees. This information would be necessary in order to proceed with the design of the station equipment. It is necessary for the manufacturer to present as well an engineered proposal as possible to insure the engineering advantages of their unit.

When the specifications have been issued and all proposals are submitted, it is then necessary to turn to the detail evaluation of all units considered. This evaluation should be approached from both the price standpoint and compressor performance. Price comparisons should be made both on a dollars per horsepower basis, and on the total price of the equipment.

Price evaluation.—In obtaining the dollars per horsepower figure care should be exercised to include all the special or extra equipment (air filters,



Typical gas scrubber installation at an El Paso Natural Gas Co. main-line station.

lube-oil coolers, mufflers, etc.) necessary for operating the unit. This is sometimes difficult, since each manufacturer does not include the same items in his standard equipment list. When the total price of the compressor equipment to be installed in the compressor station is compared to the dollar per horsepower cost of each type of compressor, an accurate economic comparison will be obtained.

Rating.—However, price evaluation is just half of the evaluation and does not represent the complete engineering picture. There are many factors involved when properly evaluating a gas-engine-driven compressor unit for a gas-transmission line. One of the first considerations should be given to the actual "brake mean effective pressure" (b.m.e.p.) being developed in the power cylinder. With an investigation of the b.m.e.p. of the unit, it is also necessary to consider the compression pressure at which the power cylinder is operating, the number of power cylinders per unit, and also the range of b.m.e.p. at which the unit is known to have been rated by the manufacturer.

With the recent advent of the higher-compression engines for compressor installations, and consequent lower fuel-consumption guarantees, it is to be noted that each general type of unit usually has several b.m.e.p. ratings, from approximately 60 to 80 psi. on a supercharged high-compression engine. The range of b.m.e.p. at which these engines may be operated is some indication of the load-carrying ability of the engine. Of course, for the higher rating, b.m.e.p.'s in any particular unit, compression pressures must be raised, and in some cases, supercharging changes must be made on the unit before it can be operated at the higher loads.

Physical dimensions.—Another useful comparison in evaluating a compressor installation is the space savings determined as square feet of floor space per horsepower. To obtain the square feet of floor space per horsepower, the minimum floor area or building area required for the installation of one unit is considered, including clearance for equipment maintenance. This floor area divided by the horsepower of the unit gives the square feet of floor space per horsepower.

Number of units.—Another primary consideration is the number of units desired in a compressor station. This is directly tied in with the flexibility desired in the station operation, and whether or not there will be a spare equipment available in the station for maximum operating conditions. If there is to be no spare horsepower purchased for the station, careful consideration should be given to the overload capacity of the engine. In case

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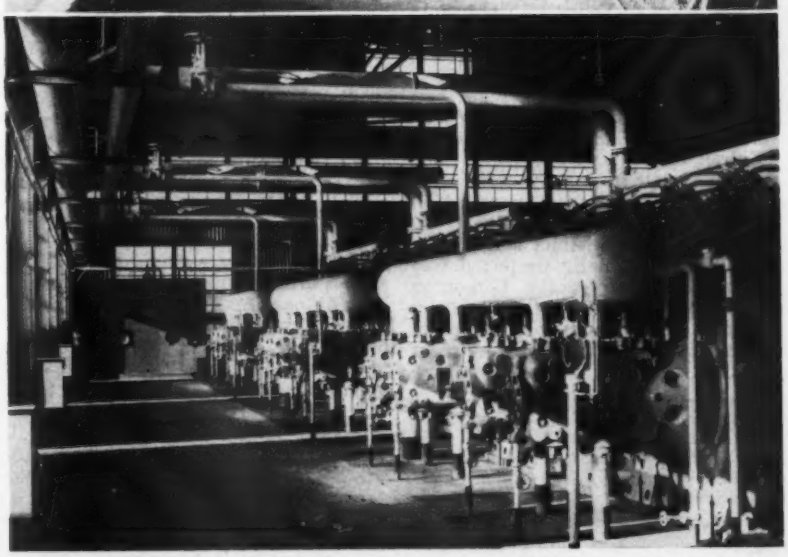

Top: Back-to-back arrangement of equipment is used in all El Paso Natural Gas Co. main-line compressor stations. Grates in the center provide access to a tunnel running full length of the building which contains all the water, gas, air, and associated piping. (Deming station) Center: Equipment layout in an auxiliary building. In the left center is the metal enclosed switchgear and in the rear are two of the motor-driven jacket water pumps. (Fullerton plant) Bottom: A typical main-line compressor installation operated by El Paso Natural Gas Co.

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Left: Heavy ice conditions were encountered by workmen laying Interprovincial's pipe line across the North Saskatchewan River, between Redwater field and Edmonton. A channel was cut through the ice. Then side-boom tractors moved in and lifted the huge blocks of ice out of the way. Right: Stringing 40-ft. joints of the big pipe on the right-of-way was completed in some sections of the Canadian prairie while snow covered the hard-frozen farmland. Here a stringing crew lifts snow-caked pipe from a truck trailer onto the right-of-way.

Interprovincial Pipe Line

PIPE-LINE Section

CONSIDERATION was given to construction of a pipe line to provide a market outlet for the new source of Canadian crude, very soon after the discovery of Leduc oil field south of Edmonton in February 1947. By the time Leduc was firmly established as one of the major oil finds on the continent in recent years, plans had crystallized for the pipe line—to run east from the Edmonton area.

Subsequent developments and changes in the western producing picture which followed resulted in the actual planning of the line being divided into two distinct stages. The pipe line as originally projected was to carry crude from the Edmonton area to refineries at Regina with any demands east of there to be supplied by rail from Regina and the first planning was done on that basis.

First Stage of Work

An engineering-design office was established in Tulsa and the first Canadian engineers to join that pioneer group arrived there late in 1948. Tulsa was selected for several reasons, chiefly because it is the headquarters of a large number of pipe-line operators and supply companies, making available to the engineering staff all the vast experience of these established companies and the representatives of equipment manufacturers, whose products would be needed in such an undertaking. In November 1949 this group moved to Edmonton where headquarters for the Interprovincial Pipe Line Co. has been established.

Aerial survey.—One of the first tasks in this initial planning stage was an aerial survey of the proposed route. Several reconnaissance flights were made early in 1948 to examine the terrain between Regina and Nisku, Alta., a small railway point near Leduc field.

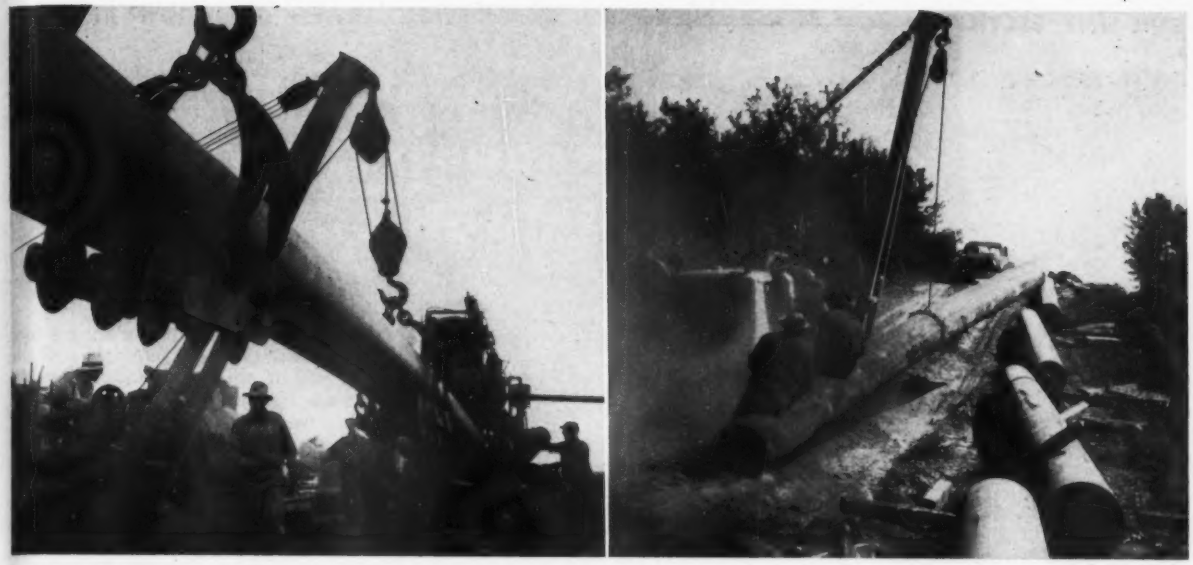
After the most favorable general route was chosen to avoid major ground contours, lakes, and difficult terrain, it was plotted on dominion government topographic maps of a scale 3 miles to the inch. A contract was then awarded to Photographic Survey Corp. of Toronto for a photographic survey of the route to provide stereos and mosaic prints for close study. Viewed through a stereoscope, contact prints showed ground contours and extreme elevations and depressions in exaggerated relief.

When the complete set of stereos was available, they were used to locate major obstacles such as farm buildings and other permanent structures on the route before the line was located on the mosaics. From the mosaics were made up plats or maps, showing the route of the pipe line which provided the information for the detailed ground survey carried out in the spring, summer, and fall of 1949. By the end of 1949 completed plans were presented to the Board of Transport for approval of the route selected.

The use of the aerial survey eliminated the necessity of a reconnaissance survey, which in the past has proven both tedious and costly.

While this part of the job was progressing, the engineers were finding the answers to many of the other vital questions which faced the pipeline planners in its earliest stages. What maximum throughputs could be delivered? How would varying temperatures affect viscosity of the crude? How much would pressure drop per mile in various diameter pipe?

By the summer of 1948, about 100 wells had been completed in Leduc field and the estimated recoverable reserves were placed at 200 million barrels. This appeared sufficient to support production adequate enough to supply the requirements of the



Left: A coating and wrapping machine progresses steadily across dry farmland in Alberta, 65 miles southeast of Edmonton. The cradles which support the pipe line ahead of the coating machine are seen in this picture. Right: Side-boom tractors are used to lift and move the 40-ft. joints of pipe on the right-of-way during construction. For better control of swinging pipe, workmen ride one end of a joint on its trip along the right-of-way. Photo taken near Camrose, Alta.

. . . A CASE HISTORY

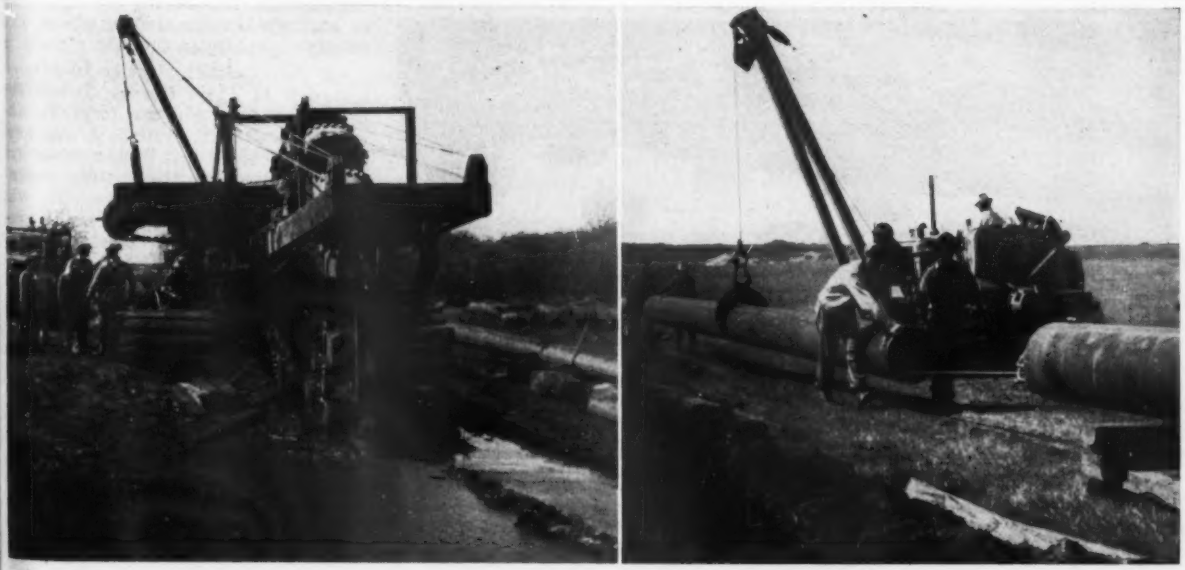
The author, executive vice president of Interprovincial Pipe Line Co., Edmonton, Alta., presents an account of the design, construction, and equipage of the largest and longest crude-oil pipe line constructed in Canada.

by Loren F. Kahle

prairie refineries by pipe line to Regina.

Pipe sizes.—Pressure-drop calculations were made for pipe of 16, 18, 20, and 22-in. o.d. with ¼, 9/32, 5/16, and 11/32-in. wall thicknesses. Curves of pressure drop per mile versus throughput up to a maximum of 110,000 bbl. a day were plotted. The number of pumping stations required for the various throughputs was calculated for the pipe sizes mentioned and for the four wall thicknesses and

Left: Melting snow and spring rains held up some of the heavy pipe-line-construction equipment in the first weeks of work on the Interprovincial project. A big ditcher, south of Brandon, Man., is shown working in heavy mud and water. Right: Side-boom cat moves a 40-ft. joint into place over the internal lineup clamp, in readiness for welding crews.



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A side-boom caterpillar plods through a small slough after topping a rise, during coating and wrapping operations on Interprovincial's Alberta project.

a graph of throughput versus line pressure was plotted.

As a result of these studies and following discussions with pipe manufacturers, the decision was reached to use 16-in. pipe. Hydraulic studies on the 18, 20, and 22-in. pipe were shelved and work was concentrated on the 16-in. with three wall thicknesses—5/16, 9/32, and ¼ in. All of this was on the basis that the pipe line would terminate at Regina.

Both steel plates and pipe were in extremely short supply at the time. In order to fill the contract for pipe, Page Hersey Tubes proceeded with construction of a completely new rolling mill at Welland, Ont., for making pipe up to 16 in. in diameter, representing an investment by them of $5,000,000.

After comparing tonnages involved and the savings to be effected by telescoping or tapering with varying wall thicknesses of pipe, it was decided that for safety and construction reasons the pipe be held to two wall thicknesses—5/16 and 9/32 in. It might be interesting to note that the saving made by telescoping, based on the then quoted prices for pipe in Canada amounted to a little more than $1,000,000.

More New Oil; Second Stage

Development drilling at Redwater, about 30 miles northeast of Edmonton, by the fall of 1948 indicated another major oil strike. The need for moving the crude into refineries supplying the more densely populated marketing areas of eastern Canada had been obvious from the start, and Redwater field provided the additional reserves to make a pipe line east of Regina economically sound. It appeared obvious then that the greater part of the Sarnia refinery's requirements could be supplied by Alberta crude. To supply Sarnia during the summer season when navigation was open on the lakes as well as the Regina and other prairie refineries, would require a capacity of approximately 90,000 bbl. a day between Edmonton and Regina.

This put the pipe-line planners into the second stage and required a whole new set of studies. Detailed investigations and studies proved Superior, Wis., was the logical terminus for the most economical route both from the standpoint of construction costs and maintenance. To build to a Canadian port on Lake Superior would have required $10,000,000 additional investment and operating costs would have been increased by 10 cents a barrel.

Change to 20-in.—One of the first results of this rapidly mounting potential production was the decision to increase the size of the pipe in the Edmonton-to-Regina section from 16 to 20 in. o.d. Using a factor of safety of 1.5 and wall-thickness tolerance of minus 12½ per cent for 42,000 and 46,000 psi. yield steel, the engineering group had established that the 16-in. line would have a maximum throughput of 125,000 bbl. a day at 1,050 psi. operating pressure with eight pumping stations. By increasing the pipe to 20 in. o.d., the throughput would be increased to 145,000 bbl. a day at the same 1,050 psi. pressure but only four pumping stations would be required.

The increase in cost of the 20-in. pipe over the 16-in. pipe was more than offset by the savings resulting from decreasing the number of pumping stations. This saving through fewer stations is estimated at about $1,000,000 annually in operating costs.

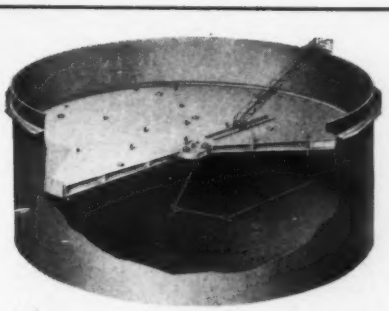
As the contract already had been awarded to Page Hersey Tubes for the 16-in. pipe for the original Edmonton-to-Regina system, it was necessary to utilize this pipe somewhere else in Canada on the eastern extension. Investigations showed it was practical to use this pipe on the section from Regina to Gretna, Man., because there would be a fairly sizable takeoff at Regina, decreasing the throughput and the required size of pipe line east of that city.

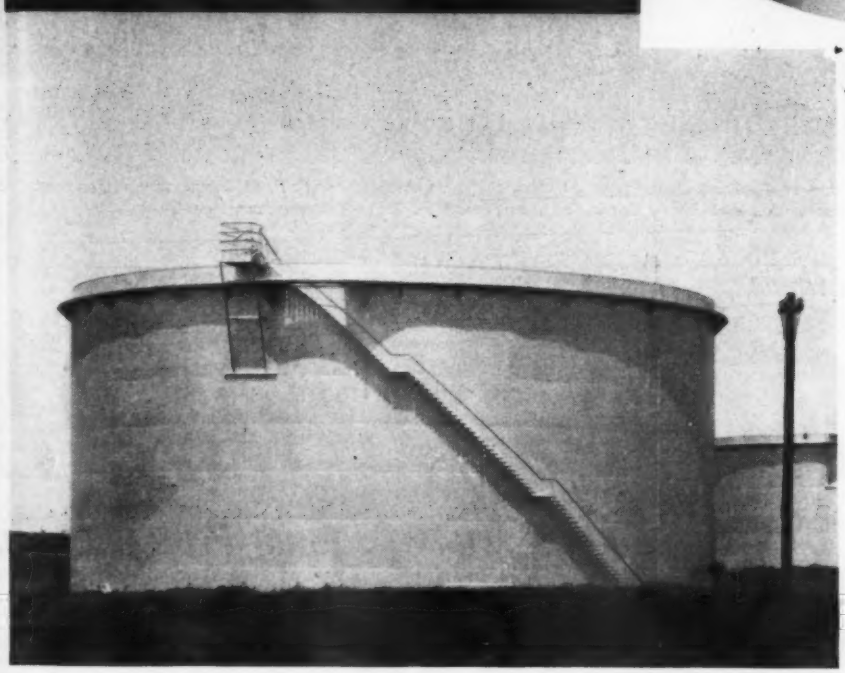
Eighteen-inch-diameter pipe was chosen for the American section of the line between the international boundary south of Gretna, Man., and Superior, Wis. This because the study showed that by using 18-in. pipe with a thinner wall—namely 9/32 in.—and operating at 837 psi. maximum pressure, considerable savings could be

(Continued on page 336)

Six storage tanks, each to hold 140,000 bbl. of crude, are almost completed at the Edmonton pumping station of Interprovincial Pipe Line Co. The pumping station itself is shown under construction on the left. Center foreground is the pipe-line right-of-way where it enters the station site, with pipe strung and the ditch already cut.

How to Cut down Corrosion— Reduce Fire Hazard





Above: Cutaway view showing construction of a Horton Double-Deck Floating Roof as installed in a butt-welded tank.

Two 125-ft. diam. by 56-ft. tanks equipped with Horton Double-Deck Floating Roofs for the storage of sour crude oil at the Shell Pipe Line Corporation's Cushing, Okla., terminal.

. . . when you store sour crudes

The rapid corrosion of the roof and upper shell of tanks storing sour crudes is due to the action of hydrogen sulfide, oxygen, and water. Furthermore, if the sour crude is stored in a fixed roof tank, the existence of a vapor space creates a fire hazard.

You can overcome both these problems by equipping each sour crude storage tank with a Horton Double-Deck Floating Roof. Since this roof floats directly on the surface of the liquid in the tank, it eliminates conditions which accelerate corrosion and create a fire hazard.

There is no vapor space under a Horton Double-Deck Floating Roof. An automatic vent releases air trapped under the roof when the tank is first filled. Corrosion in sour crude tanks is cut down because the underside of the roof is in contact with the liquid.

The elimination of the air-vapor space under the roof greatly reduces the danger of fire. Since the roof blankets the surface of the liquid, it eliminates the air necessary to support combustion.

The Horton Double-Deck Floating Roof not only gives you these two benefits . . . it also eliminates filling evaporation losses and greatly reduces standing storage losses. That's why it is widely used at pipe line terminals for storing gasoline and volatile crude oils as well as sour crude. Write today to our nearest office for full details about this efficient floating roof.

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Detroit, 26.....1514 Lafayette Bldg.
Havana.....402 Abreu Bldg.
Houston, 2.....2119 National Standard Bldg.
Los Angeles, 17....1523 General Petroleum Bldg.
New York, 6.....3347—165 Broadway Bldg.
Philadelphia, 3...1615-1700 Walnut Street Bldg.
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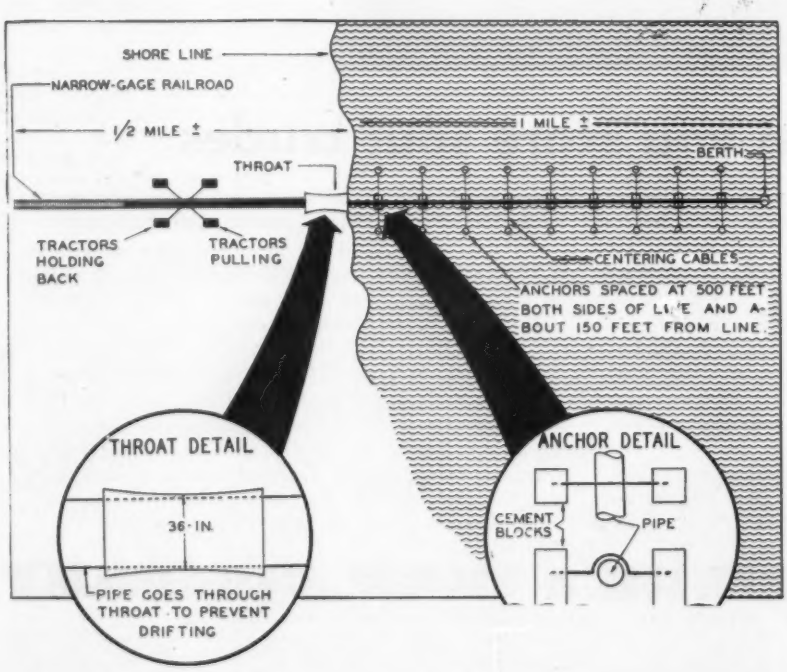
Installation operations for submarine line at Tapline's Sidon terminal. Men in the foreground are F. H. McCartney, superintendent, Williams Brothers Overseas Co., and Henry Carrington, superintendent, Trans-Arabian Pipe Line Co.

Construction of Sidon, Lebanon,

PIPE-LINE Section

MARINE TERMINAL

of Trans-Arabian Pipe Line Co.



Diagrams of operations and equipment for launching and installing submarine lines at Sidon. Top of diagram indicates narrow-gage railroad for dollies carrying string of pipe to the seashore. At end of trip, dollies drop into dolly pit in front of steel throat. Anchors with steel cables attached to the pipe at 500-ft. intervals facilitate straightening the pipe before lowering. After lowering, the submarine line is retained in position by concrete anchors.

by Paul Reed
Pipe-Line Editor

Facilities for pulling Tapline's submarine loading lines were observed by the author during a visit to the Sidon marine terminal where large tankage was under construction. This is the third of four articles on Tapline. Pump stations will be described in an early issue.

THE marine terminal of Trans-Arabian Pipe Line Co. at Sidon, Lebanon, on the Mediterranean Sea, has four offshore berths for loading crude oil into deep-sea tankers. These four berths have capacity for simultaneously loading at a combined maximum rate of 80,000 bbl. per hour. Deliveries through the company's 1,068-mile, 30-31-in. line from Abqaiq, Saudi Arabia, will be coming to Sidon at the rate of 315,000 bbl. daily when operations are at full capacity next year.

This terminal with large storage facilities is located about 4 miles south of the ancient Phoenician port of Sidon and 35 miles south of the modern city of Beirut. There are no harbors along the East Mediterranean Coast with natural protection. Beirut is partially protected by a break-

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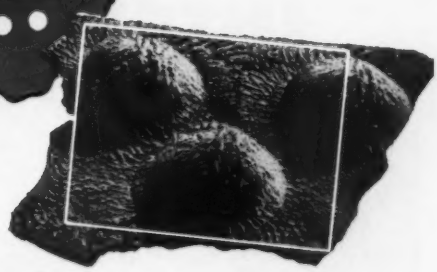

Rectangle in small photo shows area of scale sample in large illustration. "Hills" are scale-covered rivet heads. Approximate size of sample: 7" x 5". *Nalco Laboratory photo.*

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How to work an oil field

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water but the harbor is small and Tapline had to select a terminal site elsewhere fronting on the unprotected coast.

Tapline's terminal property has a frontage of 5,700 ft. on the seacoast; and it extends inland 5,800 ft. to the foothills. The anchorage and ship maneuvering area reserved for the company's operations is approximately 1½ miles wide by 2 miles long. There is a clearance of 2,600 ft. between the four offshore loading berths, each about a mile from the shore line. Water at the loading berths is 50 to 55 ft. deep. Tapline has built an L-head jetty extending about 1,000 ft. from the shore line into 20 ft. of water for landing the five 165-hp. mooring boats and other small craft. This jetty protects them from rough seas which occur occasionally during winter months.

After dealing with the construction and plan for operating terminal facilities, this article will describe the methods employed for launching the submarine loading lines which have attracted attention because of their simplicity and effectiveness. Information for this article was obtained from B. E. Hull, president; A. N. Horne, vice president, and Henry Carrington, superintendent of Trans-Arabian; and David R. Williams, vice president; A. M. Garber, project manager, and J. H. McCartney, superintendent of the Williams Brothers Overseas organization.

Tankage and Piping

The last 4.7 miles of the main line leading to the Sidon tank farm consists of 22-in. pipe with ½-in. wall thickness which has been installed to regulate back pressure and control the rate of the flow of oil. This is because in the final 65 miles the main line drops 2,500 ft. from a gap where it crosses the Lebanese mountains.

At Sidon there are presently thirteen 180,000-bbl. floating-roof crude-oil storage and working tanks, each 164 ft. in diameter by 50 ft. high; two 180,000-bbl. fuel-storage and working tanks; one 180,000-bbl. "swing" or emergency tank for either crude or fuel; one 25,000-bbl. slop tank; and three 14,000-bbl. fuel-handling tanks. All tanks are welded throughout.

The sixteen 180,000-bbl. tanks, with total capacity of 2,880,000 bbl., are of heavier construction than standard design. From the ⅞-in. first ring they taper to a ¼-in. top ring. Tanks are 164 ft. in diameter and 50 ft., 3 in. high. The bottoms of the tank rest on asbestos-fiber padding covered with a flood coat. Tanks are equipped with pontoon-type roofs of Chicago Bridge & Iron Co. design. Tank fabrication is done by Graver Construction Co. Electrical work and piping for the

(Continued on page 345)

Concrete anchors ready for installation to hold submarine lines in position. Tapline's L-head jetty is under construction in the distance.

Closeup view of concrete anchors for holding submarine lines.

Connections fabricated ready for installation at ends of submarine lines; to these connections hoses are attached through which oil finally enters tanker piping.

Welding machines engaged in fabrication of 180,000-bbl. tanks at Sidon terminal.

XUM

A Method for

COMPUTING SIZE OF TANKS

at Product Pipe-Line Terminals

PIPE-LINE Section

by Spencer A. Hallberg

SINCE cost of terminal tankage is a major item in the initial investment of product pipe-line terminals, it is important that consideration be given to erecting the proper size tanks at each terminal. When calculating tankage, it is essential that a tank size be provided that allows for future increases in terminal throughput, as well as working room in tank for operation of the line under adverse conditions. It is also important not to erect excessive tankage because tankage above requirements means an unnecessary expenditure of money for capital investment.

With costs and pipe-line operations in mind, a formula, based on operating experience, has been derived by the products pipe-line department of Standard Oil Co. (Ind.). It is currently in use by this company for tankage calculations. This formula provides a safe minimum-size tank to handle required terminal volume, which is flexible enough to provide tankage for any reasonable increase in terminal throughput without increasing the normal number of tenders of products pumped each month.

Basis of Method

One tank is provided for each product at a terminal for normal operation and the formula is developed on this basis. However, if it is desired to construct more than one tank for a specific product at a given terminal, the total tank volume determined from the formula, before adding outages, can be divided by the number of equal volume tanks desired and the proper size tanks determined after considering the allowances for outages, as explained later.

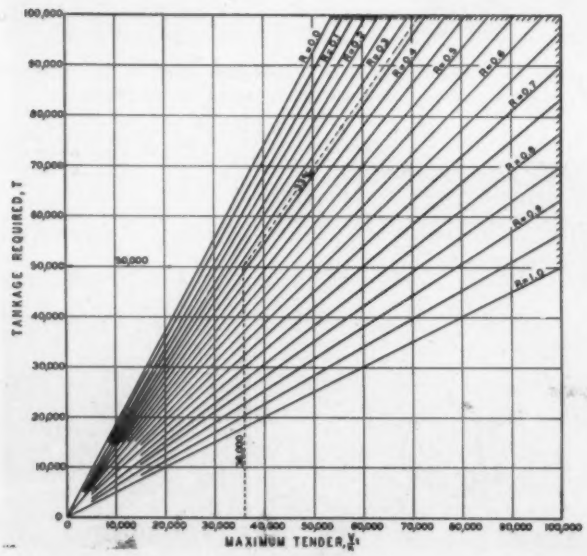
To compute tank sizes, an empirical method has been developed which follows. However, in order to minimize the amount of time required to calculate tank sizes, the empirical method has been reduced to a formula. A graph has been developed from this formula for speed and simplicity.

The volume to be used in calculating the proper size tank for a specific product for a given terminal must be obtained by an analysis of a 5-year forecast of estimated volume requirements in order to be sure the tank selected will be adequate to meet future demands. The volume selected will be the maximum estimated to be shipped from the terminal in any month during such period and the corresponding pipe-line volumes for that month.

Spencer A. Hallberg is supervisor of scheduling and dispatching, products pipe-line department, Standard Oil Co. (Ind.). Hallberg received his B.B.A. degree from Texas Christian University in 1934. From 1934 to 1943 he worked in the accounting department of Texas Pacific Coal & Oil Co., Fort Worth. He entered the Army in 1943 and served as warrant officer until released in 1946, at which time he joined his present company.

Data required.—The following information must be obtained or calculated in a stepwise procedure:

1. **Maximum monthly volume** of the product to be shipped from the terminal.
2. **Total monthly volume** of the



Graph 1

MINIMUM TANKAGE REQUIREMENTS FOR PIPE-LINE TERMINALS (Normal)

$$T = \frac{V_t}{n}(11/6 - 4R/3)$$

Nomenclature:

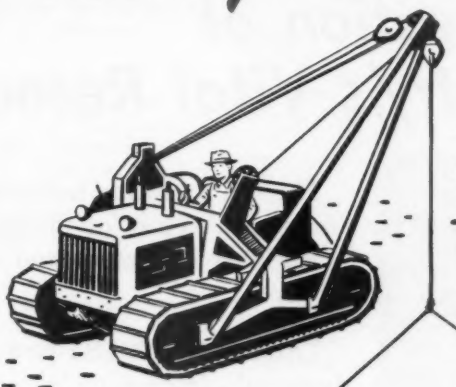
- T = working tank volume required (excluding allowance for week-end arrival; and tops and bottoms).
- V_t = maximum monthly volume of the product to be shipped from the terminal in barrels.
- n = normal number of tenders of the product to be pumped during each month.
- R = portion of the month the terminal will receive product.
- $R = V_p/V_L$.
- V_p = total monthly volume of the product to be pumped through the pipe line immediately upstream from the terminal in barrels.
- V_L = total monthly volume of all products to be pumped through the pipe line immediately upstream from the terminal in barrels.

Week-end arrival = $V_t/15$.

Directions:

1. Calculate the maximum (V_t/n) and the portion of the month the terminal will receive the product (R).
2. Find the intersection of the above (V_t/n and R).
3. Read the tankage required on the tankage (T) scale.
4. Add allowance for week-end arrival ($V_t/15$) and tops and bottoms.
5. If the maximum tender (V_t/n) is greater than 100,000 multiply its scale and the tankage (T) scale by 10. Conversely, if the maximum tender is less than 100,000 divide its scale and tankage scale by 10.

Where BIG Pipelines are being Built*



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product to be pumped through the pipe line immediately upstream from the terminal.

3. **Total monthly volume** of all products to be pumped through the pipe line immediately upstream from the terminal.

4. **Normal number of tenders** of the product to be pumped during each month.

5. **Number of days** the terminal will receive the product during that month.

6. **Daily average shipments** of the product from the terminal.

7. **Quantity of product** that will be shipped from the terminal tank **while it is being received.** (Tank space is not required for stock shipped while receiving.)

8. **Quantity of product** required for shipment from the terminal **while it is not being received.** (Adequate stock must be available while other products are being received and pumped past the terminal.)

9. **Quantity of product** that will be required for shipment from the terminal **between tenders.**

10. **Determine maximum tender** of the product to the terminal by dividing the maximum monthly volume by the normal number of tenders per month.

11. **Calculate allowance for undershipments** of the product during the month by dividing the maximum tender by two, as determined by Step 10.

12. **Compute allowance of overshipments** of product during the month by dividing the quantity required for shipment between tenders by three, as determined by Step 9.

13. **Allowance for arrival of product on nonshipping days** (week-end arrival) by multiplying the daily average shipping rate by two.

14. **Add calculated volumes** to determine total working tank volume required. (Add items 9, 11, 12, and 13 above.)

15. **An allowance of outages** (unavailable tank space) for tops and bottoms. Outages are added after proper tank size is determined, since allowance varies with diameter and type of tank. (Normally, 3 ft. of space is allowed for both tops and bottoms for cone-roof tanks and 4 ft. of space for floating-roof or lifter-type tanks.)

The following example explains how the size of the terminal tank is determined by the empirical method:

Problem: To calculate size of tank required for heater oil No. 1 at Terminal "X."

Conditions:

1. Maximum monthly volume to be shipped from Terminal "X" = 72,000 bbl.

2. Total monthly volume of heater oil No. 1 pumped through the pipe line immediately upstream from Terminal "X" = 300,000 bbl.

3. Total monthly volume of all products to be pumped through the pipe line immediately upstream from Terminal "X" = 900,000 bbl.

4. Normal number of tenders of the product to be pumped during each month = 2.

(In a 30-day month, with two tenders per month, tenders are 15 days apart.)

Calculations:

5. Determine number of days Terminal "X" will receive heater oil No. 1:

$$\frac{300{,}000}{900{,}000} = 33\tfrac{1}{3} \text{ per cent of 30 days}$$

$$= 10 \text{ days}$$

6. Determine daily average shipments of heater oil No. 1 from Terminal "X":

72,000 bbl. ÷ 30 days = 2,400 bbl. per day

7. Determine the quantity of heater oil No. 1 being shipped from Terminal "X" while it is being received:

2,400 bbl. per day × 10 days = 24,000 bbl.

8. Determine the quantity of heater oil No. 1 required for shipment from Terminal "X" while it is **not** being received:

72,000 bbl. — 24,000 bbl. = 48,000 bbl.

9. Determine quantity of heater oil No. 1 required for shipment from Terminal "X" between tenders:

48,000 bbl. ÷ 2 tenders per month = 24,000 bbl.

10. Determine maximum tender of heater oil No. 1 to Terminal "X":

72,000 bbl. per month ÷ 2 tenders per month = 36,000 bbl.

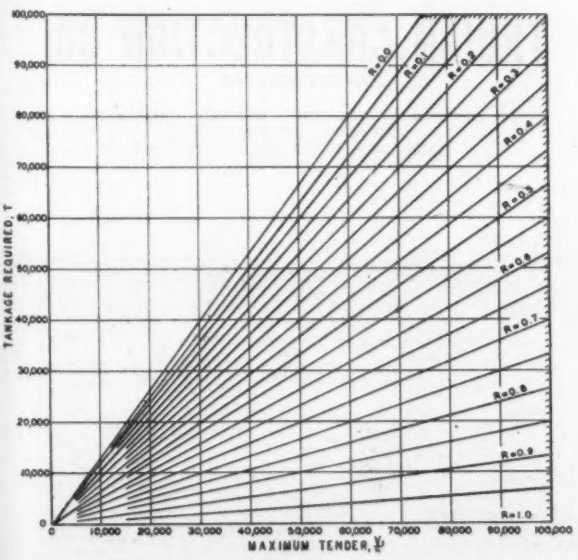
11. Determine allowance for undershipments of heater oil No. 1 from Terminal "X":

½ of 36,000 bbl. = 18,000 bbl.

12. Determine allowance for overshipments of heater oil No. 1 from Terminal "X":

⅓ of 24,000 bbl. = 8,000 bbl.

(Continued on page 356)



Graph 2

MINIMUM TANKAGE REQUIREMENTS FOR PIPE-LINE TERMINALS (Near Refineries or Source of Supply)

$$T = \frac{4}{3}\frac{V_t}{n}(1 - R)$$

Nomenclature:

- T = working tank volume required (excluding allowance for week-end arrival; and tops and bottoms).
- V_t = maximum monthly volume of the product to be shipped from the terminal in barrels.
- n = normal number of tenders of the product to be pumped during each month.
- R = portion of the month the terminal will receive product. $R = V_p/V_L$.
- V_p = total monthly volume of the product to be pumped through the pipe line immediately upstream from the terminal in barrels.
- V_L = total monthly volume of all products to be pumped through the pipe line immediately upstream from the terminal in barrels.

Week-end arrival = $V_t/15$.

Directions:

1. Calculate the maximum (V_t/n) and the portion of the month the terminal will receive the product (R).
2. Find the intersection of the above (V_t/n and R).
3. Read the tankage required on the tankage (T) scale.
4. Add allowance for week-end arrival ($V_t/15$) and tops and bottoms.
5. If the maximum tender (V_t/n) is greater than 100,000 multiply its scale and the tankage (T) scale by 10. Conversely, if the maximum tender is less than 100,000 divide its scale and tankage scale by 10.

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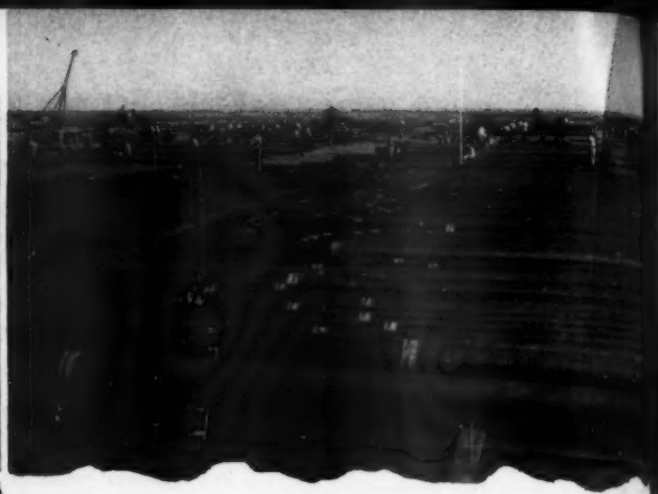

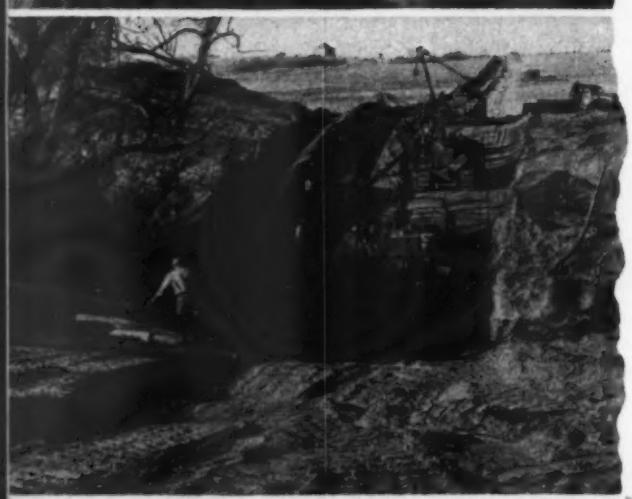

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Practical Application of

Large-Clearance Compressor Cylinders

to gas-transmission lines

by O. H. Moore

THE operating experience of Tennessee Gas Transmission Co. indicates that the selection of the compressor cylinders to be used in a cross-country gas-transmission line is of utmost importance to the future operation of the equipment. Progressive growth of the system creates changes which, in turn, cause a fluctuation in the operating pressures.

Even though an extensive long-range study is made in the initial plans as to pipe-line capacity, pipe diameter, compressor-station spacing, gas-purchase and sales points, there is little similarity between the operating conditions after the system is put into operation, and those predicted in the initial design. This inability to predict the future, however, is not to be condemned, as many factors enter the picture after construction gets under way.

The size of the system in itself is one of the major factors affecting operation. Any sizable stepup in the total sales creates a construction program all along the line. Many months are required to complete the work, and the progress of the work is reflected in operating pressures as each completed job is put into operation.

Fig. 1, showing monthly average ratios of pressures for 4 of the 14 stations in operation since 1946, is typical of all other T.G.T. plants. The operating pressures at these plants have varied through 1.18 to 2.28 range of ratios, with hardly two successive months remaining the same. It is also noted that several months of elapsed time occurs between major changes in the ratios. For example, station No. 13 started operation in January 1946 on a ratio of 1.3 and in 14 months the ratio had increased to 1.9. Then in 2 months, it had dropped to 1.73, back to 1.9 in another 9 months, and then in another 6 months it dropped to 1.18, remaining below 1.4 for a period of 17 months.

Operating pressures do not change materially from day to day, but as new facilities are put into operation (or for that matter if the new facilities fail to get into operation) pressures change proportionately throughout the line.

The critical stages of operation occur when the ratios drop to the low points. Unless provision is made to load the engines at these low ratios, the station personnel are forced to operate the equipment at a very light load, and in most instances, 100 per cent of the time for a long period.

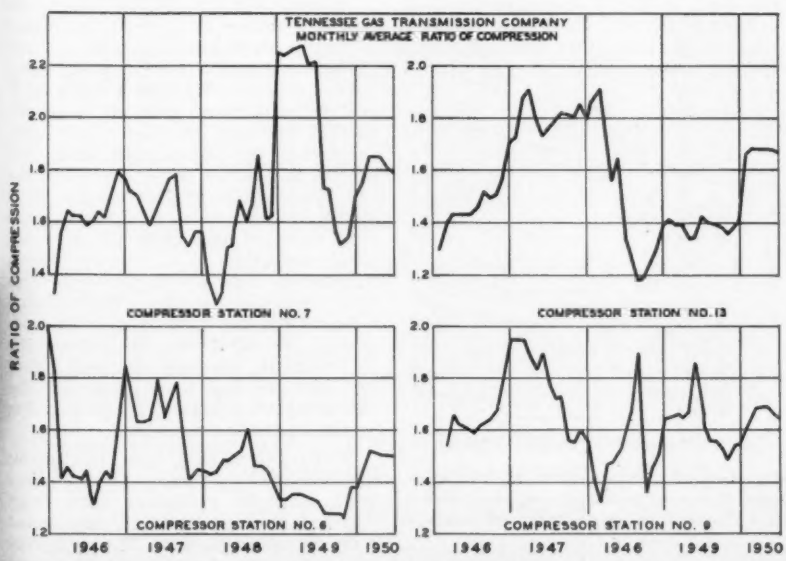

Fig. 1—Monthly average-ratio plots on pressures for 4 of the 14 stations in operation since 1946.

O. H. Moore is compressor superintendent for Tennessee Gas Transmission Co., a post he has held since 1943. He graduated from Texas A. & M. College in 1926, and joined Lone Star Gas Co. He was appointed assistant compressor superintendent in 1929, which position he held until he joined T. G. T.

PIPE-LINE Section

With proper selection of the compressor cylinders, full load can be maintained through a wide range of ratios. Maintaining this full load in the low ratios will increase each engine's capacity to the point where equipment can be shut down. This will not only save fuel, but gives the operators a chance to make badly needed engine repairs.

Since the ratios of pressures are normally maintained below 2 in the long transmission line, it is extremely important that the shape of the load curve of the compressor cylinder operating under this condition be examined.

The four curves in Fig. 2 show rather clearly the effect of variable clearance and ratio of compression on the loading ability of the 10 by 14-in. cylinder. It is apparent from these curves that the imaginary line drawn through the peak points of the curves determines the most satisfactory ratio of compression for each per cent clearance in the cylinder. It is obvious that the small-clearance cylinder should be used for ratios above 2, and the large-clearance cylinder for ratios below 2. Cylinder size and clearance must of necessity be selected to load the engine, and the most

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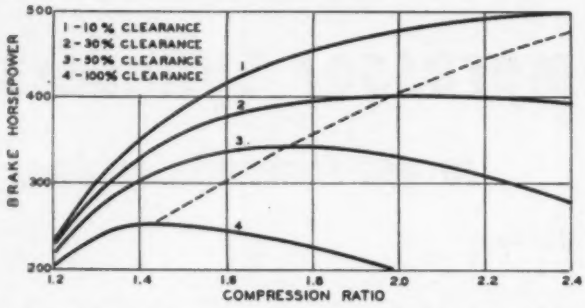


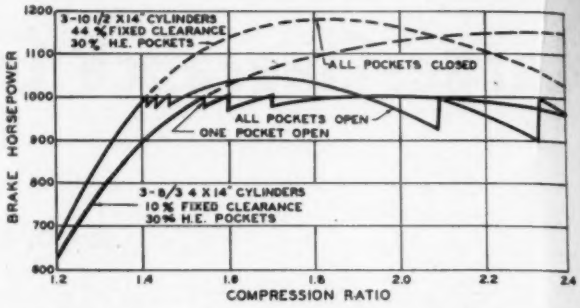


Fig. 2—(Left) Effect of variable clearance and ratio of compression on loading ability of 10-by-14-in. cylinder. Fig. 3—(Right) Load curves on large fixed clearance in combination with clearance pockets, and fixed clearance combined with large clearance pockets.

satisfactory curve is the one peaking near the design ratio.

A still flatter load curve is possible by the use of clearance pockets in combination with large fixed clearance. In using the true purpose of clearance, it is possible to keep the engine on full load on ratios both above and below the design point by putting some of the clearance in pockets.

Selection of the load curve is entirely up to the discretion of the designing engineer. If he selects a large fixed clearance and uses it in combination with clearance pockets, the load curve of the cylinders will be relatively smooth; whereas, if he selects a cylinder with a fixed clearance and large clearance pockets, the operating curve of the cylinder will not be very smooth. On the other hand, if he selects a cylinder with small clearance and then only uses clearance to unload the cylinder at higher ratios, he sacrifices engine load on ratios below the design point. Two types of load curves shown in Fig. 3 best illustrate the point in question.

The load curve for the three 8¾-in. cylinders with 10 per cent fixed clearance and 30 per cent head end pocket shows loading ability of one arrangement of cylinders that we have in operation as compared to another set of three 10½-in. cylinders with 44 per cent fixed clearance and 30 per cent head end pocket. The 10½-in. cylinders were selected because indications were that they would be required to operate on 1.4 ratio. These 10½-cylinders give 10 per cent more load at the 1.4 ratio than the 8¾-in. cylinders in T.G. T. operations. This 10 per cent increase in load means more gas compressed.

It has been possible for us to improve the load curve on a number of our engines either by a change in liner size or cylinder replacement. Curves 1 in Fig. 4 represent the load curves of the cylinders purchased on the first engines. With definite trends toward lower ratios of pressure, it became necessary that we improve these load curves. Curves 2 are the improved load curve. Just how these improvements were accomplished is explained later on in the article.

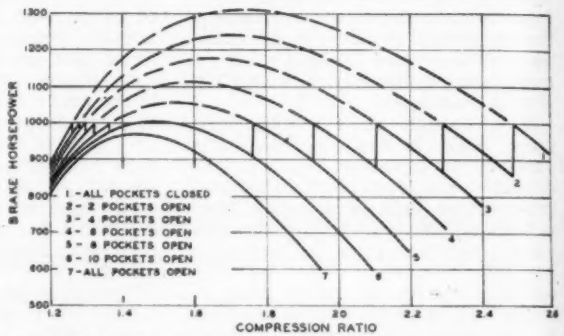

1 - ALL POCKETS CLOSED
2 - 2 POCKETS OPEN
3 - 4 POCKETS OPEN
4 - 6 POCKETS OPEN
5 - 8 POCKETS OPEN
6 - 10 POCKETS OPEN
7 - ALL POCKETS OPEN
BRAKE HORSEPOWER
COMPRESSION RATIO

Fig. 5—Typical load curve on new cylinders being purchased by T.G.T.

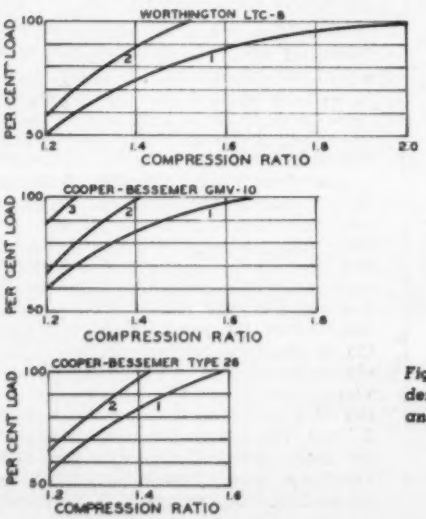
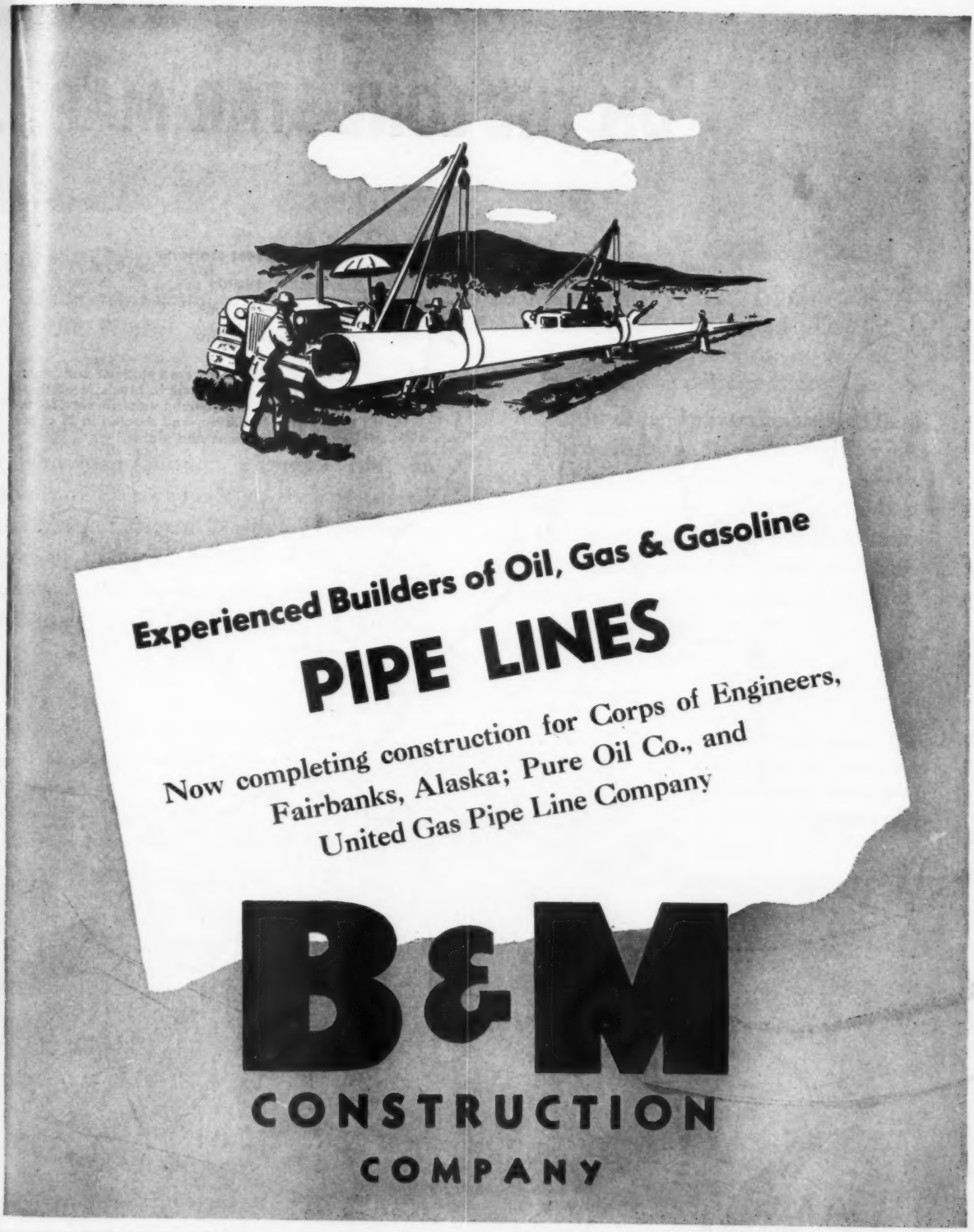


Fig. 4—Load curves on five different cylinders. Curves 1 represent original cylinders and Curves 2 represent improved loadings.

It would be amiss to pass on from Fig. 4 without pointing out another use of the curves. The practice of calculating horsepower requirements on a horsepower-per-million basis can backfire unless the actual horsepower of the compressor cylinder is taken into consideration for the various ratios of pressure. Had the loading ability of the various units not been improved it would have been necessary to derate this equipment when required to operate on ratios below the designed load point. In some instances it would have been necessary to derate some of the units 25 per cent when operating on a 1.4 ratio. Curves 2 indicate that all equipment, with the exception of the Worthington LTC-8 Unit, can now operate at practically 100 per cent full load on the 1.4 ratio. It was only necessary that we improve the load curve on the Worthington engine to a 1.5 ratio due to the operating pressures.

When purchasing new equipment present T.G.T. policy is to select large-diameter cylinders with large fixed clearance, used in combination with clearance pockets. The cylinders are to operate at maximum clearance through the designed ratio. Full load is then maintained at ratios below



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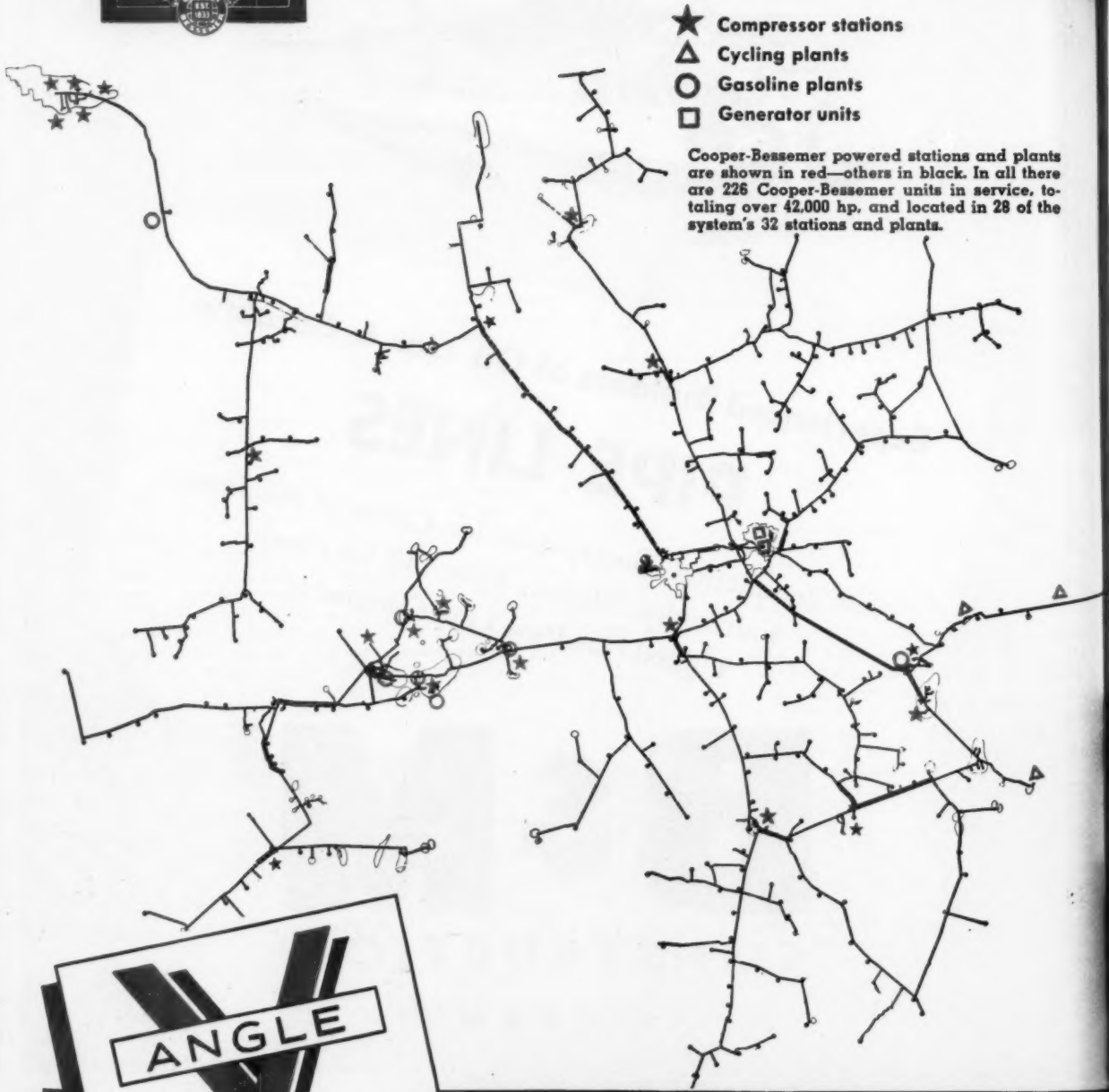
Another Example of Efficient Power at Lower Cost

ON THE LONE STAR MAP...


Compressor stations
Cycling plants
Gasoline plants
Generator units
Cooper-Bessemer powered stations and plants are shown in red—others in black. In all there are 226 Cooper-Bessemer units in service, totaling over 42,000 hp, and located in 28 of the system's 32 stations and plants.

ANGLE

Compressors

New York Washington, D. C. Bradford, Pa. Parkersburg, W. Va.
San Francisco, Cal. Houston, Dallas, Greggton, Pampa and Odessa, Texas Seattle, Wash.

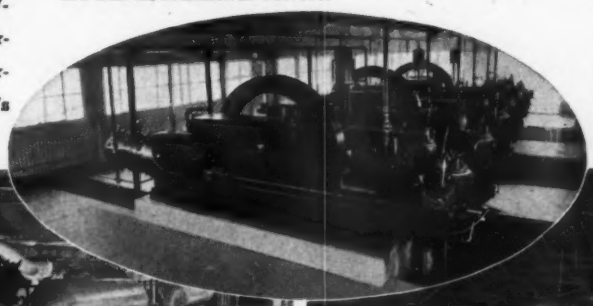
. . . . 30 years of Cooper-Bessemer power from early horizontals to the latest GMV Turboflows

THE map pictures the Lone Star Gas Company's complex system as it is today. It is also evidence of this company's progress, wise management, sound growth . . . and success.

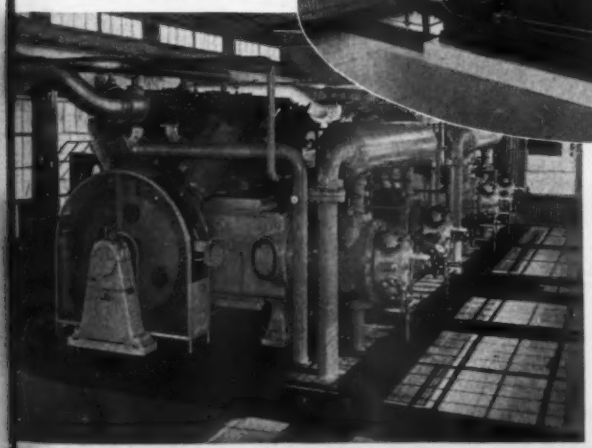
For over 30 years, Cooper-Bessemer has continuously played a major part in meeting Lone Star's power needs of every description . . . engine-driven compressor units, large and small, for gas transmission, cycling and natural gasoline service . . . gas engines of various types for driving auxiliaries and electric generators. Most of the earliest Cooper-Bessemer units, 30 years old and older, are still in regular service, giving efficient, dependable performance!

It's this kind of performance that justifies the confidence Lone Star and other companies show in Cooper-Bessemer products and engineering. It will continue to work to Lone Star's advantage with their latest Cooper-Bessemers—modern GMV Turboflows, for compressor service at lower-than-ever cost.

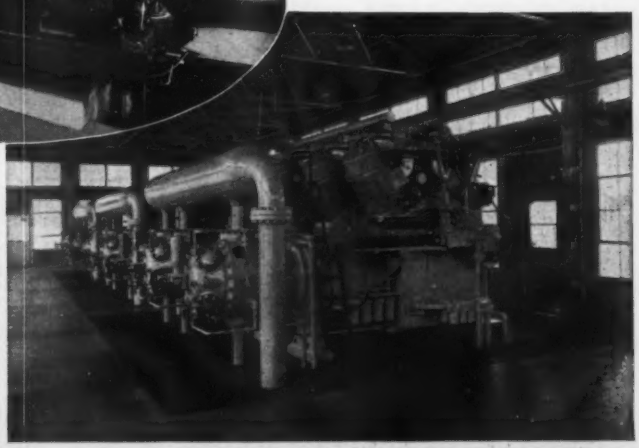
These Cooper-Bessemer 170 hp Type 75 horizontal compressors, installed in Fox Station 22 years ago, are still in continuous service.



Two modern, latest type V-angle compressors, Cooper-Bessemer 660 hp GMV-6 Turboflow units, in Lone Star's Gainesville Station.



Line-up of three Cooper-Bessemer GMV-8 Turboflow compressors, 880 hp each added last year to Lone Star's Fox Station.



s by **Cooper-Bessemer**

MOUNT VERNON, OHIO AND GROVE CITY, PENNA.

Tulsa Shreveport St. Louis Los Angeles Chicago Caracas, Venezuela

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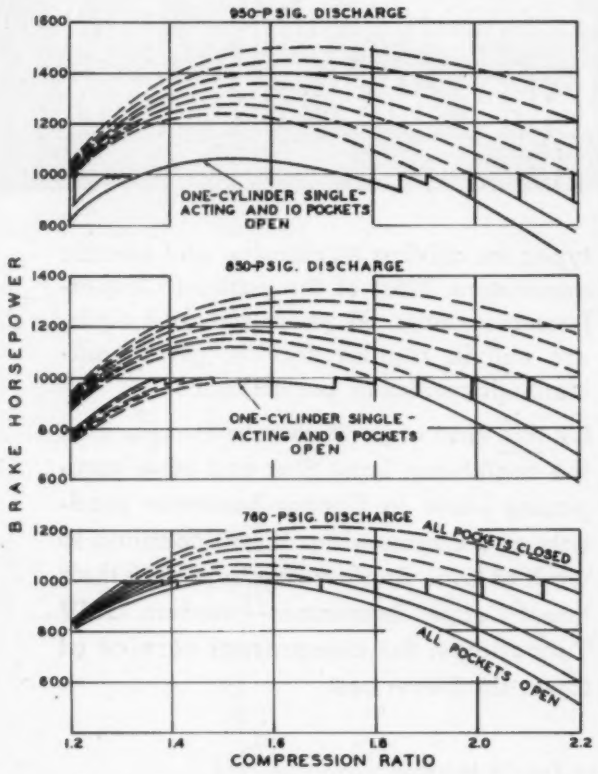

Fig. 6—Load curve on compressor cylinders recently installed in T.G.T. compressor station No. 14.

Fig. 7—A cylinder equipped with special clearance valve caps.

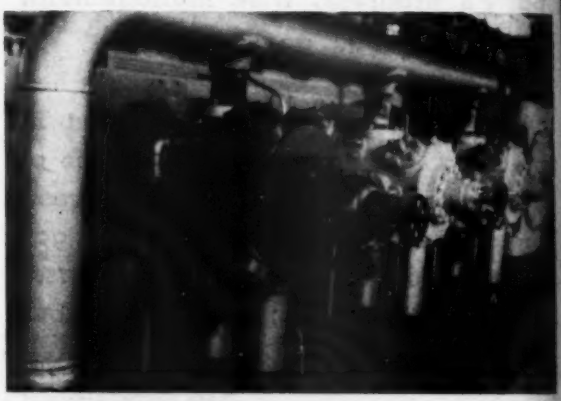

Fig. 9—Large-diameter cylinder with large clearance pocket replacing original cylinder on the unit shown in foreground.

and above the designed point by a simple manipulation of clearance pockets.

A typical load curve of the new cylinders now being purchased by T.G.T. is shown in Fig. 5. These particular cylinders as selected were for a standard GMV-10 Cooper-Bessemer unit and were selected to load the unit from a 1.25 to a 2.5 ratio on 1,000-hp. basis. This particular arrangement was made purposely, since conversion of the standard engine to the turbo-flow type is being contemplated, thus making it a 1,100-hp. unit. In this case full load can be maintained from a 1.33 to a 2.3 ratio by simply closing off clearance pockets.

Fig. 6 shows the load curve of the compressor cylinders recently installed in T.G.T.'s compressor station No. 14, where a wide range in discharge pressures is expected. The compressor units can be operated from a 1.31 to a 2.25 ratio on a 760-psi. discharge, with rated load being maintained by manipulation of the clearance pockets.

With an ordered discharge of 850 psi. it will be necessary to unload one end of one cylinder and then by manipulation of the clearance pockets, rated load can be maintained from 1.3 to 2.42 ratio.

With an ordered discharge of 950 psi., rated load can be maintained from a 1.17 to a 2.53 ratio of compression by unloading one end of one cylinder and by full use of clearance pockets.

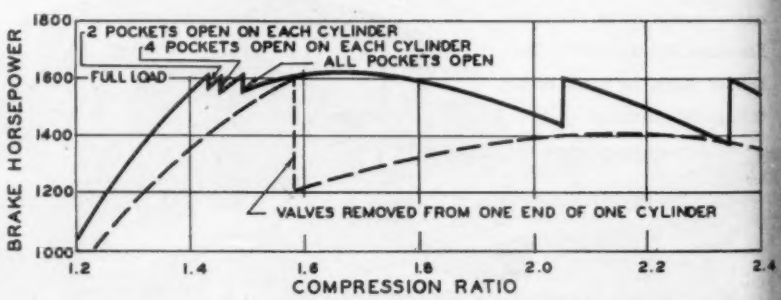
2 POCKETS OPEN ON EACH CYLINDER
4 POCKETS OPEN ON EACH CYLINDER
ALL POCKETS OPEN
FULL LOAD
VALVES REMOVED FROM ONE END OF ONE CYLINDER
BRAKE HORSEPOWER
COMPRESSION RATIO

Fig. 8—Comparison of load curves on 13½ (dashed line) and 15½ (solid line) cylinders.

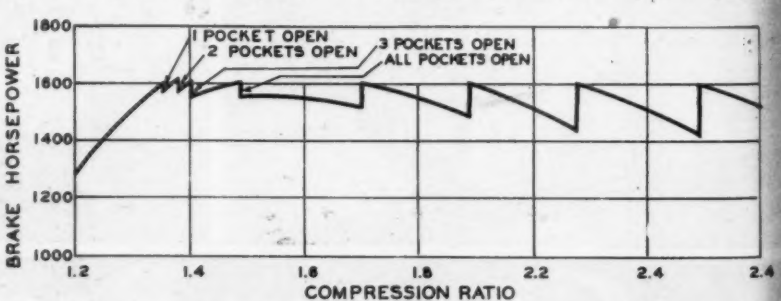

Fig. 10—Load curve on 10½-in. cylinders. Discharge pressure 760 psig.

With the development of the double-deck valve, standard clearance cylinders on T.G.T.'s Type 26 hori-

(Continued on page 358)

SEP

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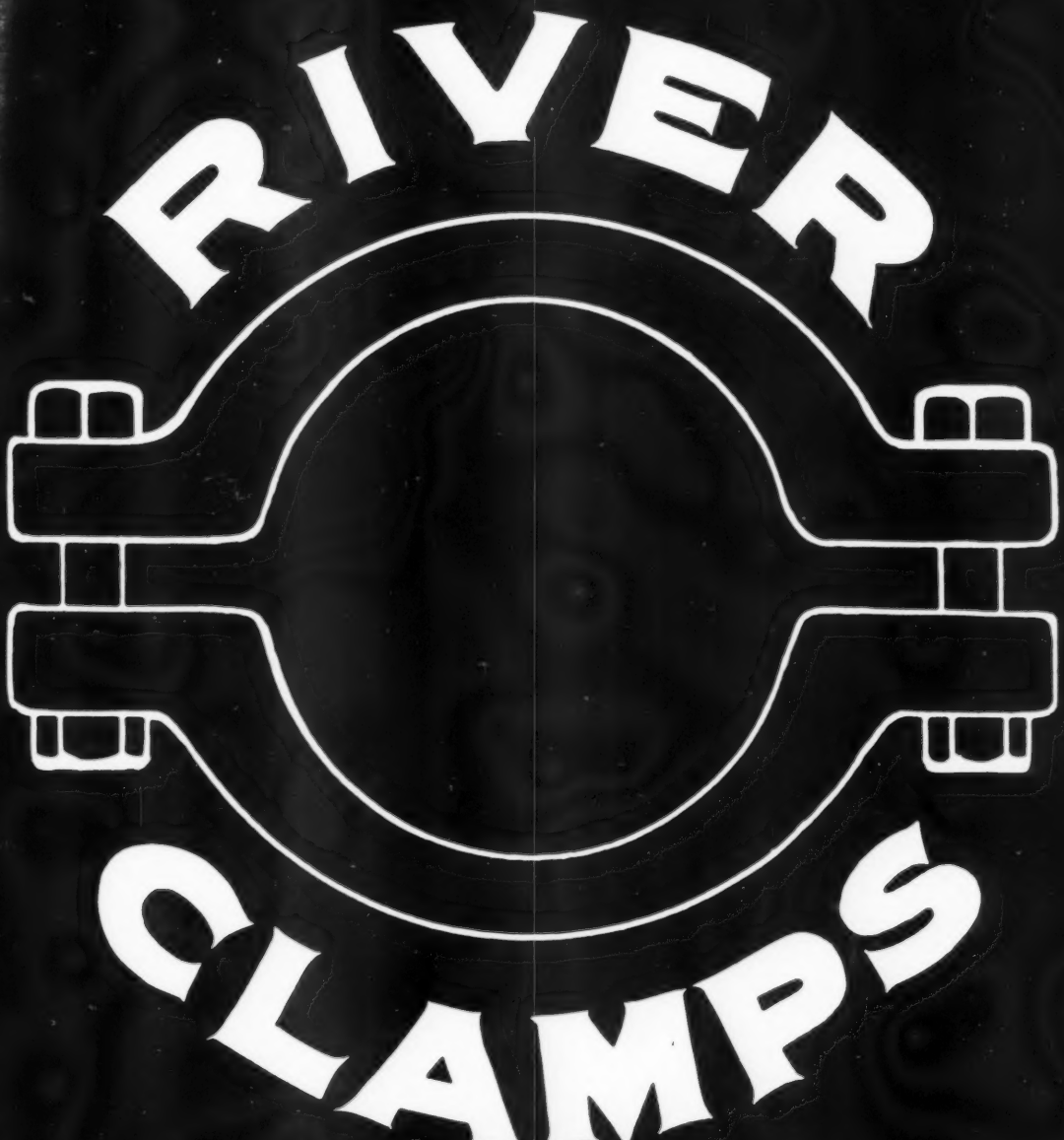

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Developments in Compressor-Station Design

by Howard L. Cline

DURING the last half century remarkable progress has been achieved in design and construction of gas compressor stations. In view of the progress made over this period, it might be possible to find examples of each major advancement still in operation on some of the older pipeline systems. From a modest beginning featuring a single steam-driven reciprocating compressor one can now thrill to large and complex multi-unit installations aggregating more than 20,000 hp. in the prime movers.

Such development is the result of vastly increased demands and uses for natural gas, which likewise have stimulated discoveries and accumulations of large reserves and the development and manufacture in great quantities of large-diameter high-tensile steel pipe to make long-distance, high-pressure gas transportation economically feasible and common.

Compressor Units

The original steam-driven compressor units were superseded by horizontal type gas engine-driven units ranging in size from 50 to 1,600 hp. Such units have been in wide use since around 1905 and are still popular because of good design, excellent load characteristics, and relatively slow rotative speeds. A few improvements which have helped maintain this popularity are (1) improved valve design; (2) better cylinder and jacket design, particularly with respect to water courses, eliminating "hot spots" and minimizing

Howard L. Cline is assistant superintendent of compressor stations, Cities Service Gas Co., Wichita, Kan. He was employed by Empire Pipeline Co., upon graduation from the school of mechanical engineering, Oklahoma A. & M. College, in 1933. In 1936 he transferred to the engineering department of Cities Service Oil Co. Since 1940 he has been engaged in the design, construction, and operation of gas compressor stations for Cities Service Gas Co.

PIPE-LINE Section

Fig. 2—A battery of 15 angle-type 1,000-hp. compressor units in station service.

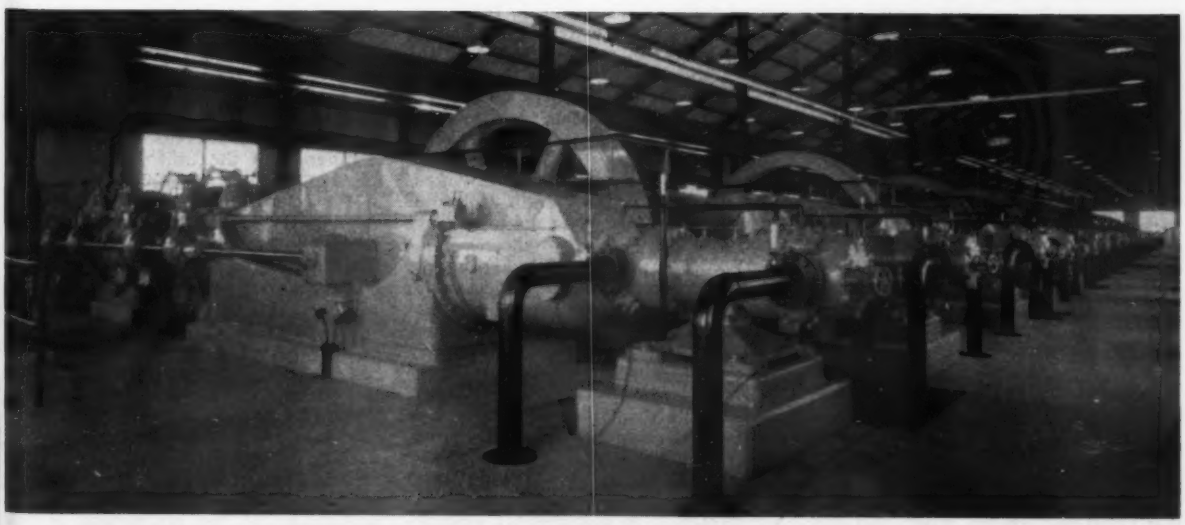

Fig. 1—Rating on these 13 horizontal compressor units totals 20,800 hp. This compressor-station installation was placed in service recently.

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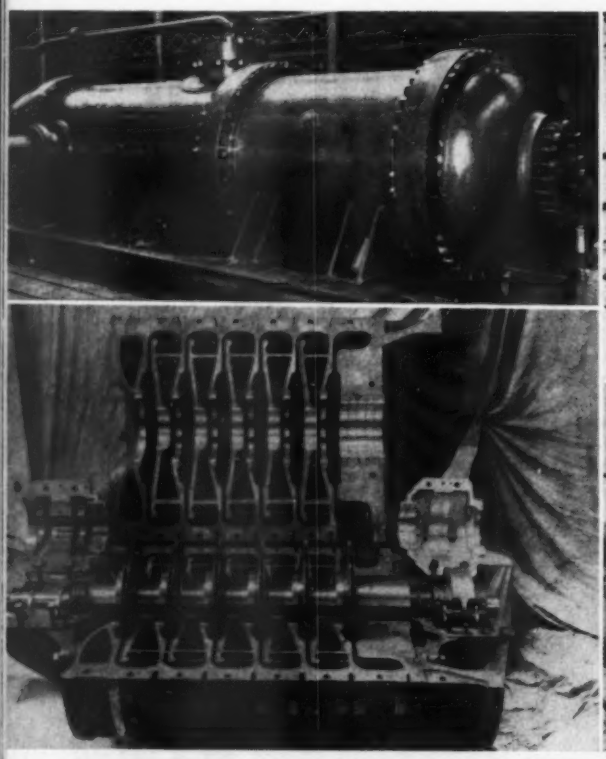


Fig. 3—Two views of a centrifugal compressor unit which was installed on an experimental basis in compressor-station service. Above, the shell or housing which contains both compressor and motor. Below, the centrifugal compressor.

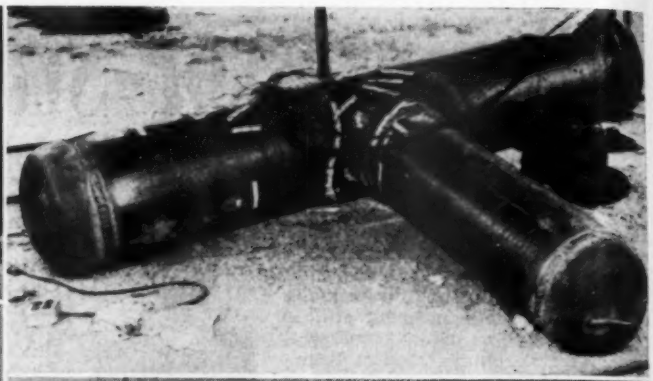


Fig. 4—(Above) A fabricated tee section undergoing test. Electronic strain gages are employed in this test to determine stress distribution.

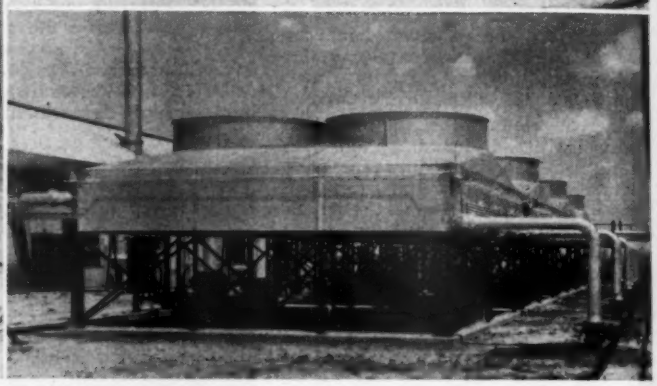


Fig. 5—(Below). This battery of aerial coolers are installed in a recently completed compressor station.

cylinder cracking; (3) better ignition and possibly the separation of jacket and rod cooling water circuits. Fig. 1 shows a recent installation of thirteen 1,600-hp. horizontal compressor units.

The newer angle-type units, introduced around 1937, are manufactured in sizes up to 2,500 hp. These units usually employ a two-stroke-cycle engine operating around 325 r.p.m., and have been a popular type unit over the past 10 years or so. A few improvements which have increased their utility include high-compression power cylinder design, lower fuel consumption per horsepower-hour, and supercharging and improved scavenging which have made possible increased horsepower up to 25 per cent on the same engine frame. Fig. 2 shows an installation of fifteen 1,000-hp. angle-type compressor units.

The above discussion has dealt with reciprocating engines and compressors only. However, the industry has experimented with centrifugal-type compressor units for quite some time. In 1932, Cities Service Gas Co. installed the first electric-motor-driven centrifugal compressor unit and operated it experimentally. This unit is illustrated in Fig. 3. This unit was rated at 3,000 hp. input, and was totally enclosed, with the motor direct connected to and located in the same shell with the compressor. The reason for this arrangement was the difficulty in devising a satisfactory seal at the compressor shaft.

Another major difficulty encountered during the experimental operation of the centrifugal unit was the breakdown of insulation in the motor windings due to the passage of wet gas through the motor. However, the most objectionable feature was high operating power cost. Subsequent development of a satisfactory shaft seal and modern improvement in the compressor have made the electric-motor-driven centrifugal-type compressor practicable, and numerous installations have been made and are in daily use.

As stated previously, wide use of the centrifugal compressor on gas pipe-line systems has been dependent upon the development of a shaft pressure seal capable of functioning at operating pressures of 900 to 1,000 psi., and a prime mover which would match the operating characteristics of the centrifugal compressor while using a cheap available fuel.

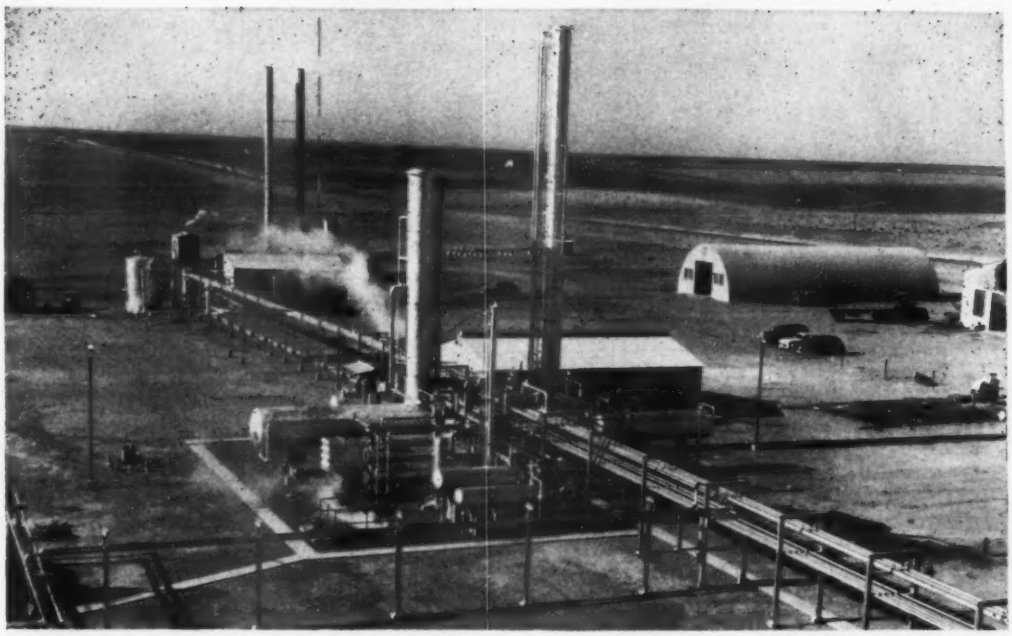
The high-speed gas turbine as a prime mover has performed quite satisfactorily in commercial electric-power-generating service in addition to successful trial operations in gas-transmission systems. Numerous other permanent installations are under way in both classes of service, and their performance will be of great interest to prospective users.

Basically, the fundamental design of the gas turbine includes a centrifugal air compressor, combustion chamber, and a turbine which drives both the air compressor and the load. The basic design has been modified to use heat from the combustion chamber exhaust, to preheat the intake air. This increases the thermal efficiency of the unit from 17 to 27 per cent. Other modifications include the use of multistage turbines with split shaft whereby one or more stages drive the air compressor and the remaining stages drive the load.

Possible advantages of the gas-turbine-driven centrifugal gas compressor unit are: (1) elimination of reciprocating parts with resulting minimum wear, vibration and pulsating gas flow; (2) lower installation costs due to elimination of massive foundations, large buildings, water-cooling equipment for the prime mover, and (3) reduced operating personnel. The greatest possible disadvantage of the equipment is the

(Continued on page 361)

New Kansas Plant *brings gas to Denver*



Gasoline Plant, designed and constructed by Stearns-Roger at Lakin, Kansas, went into operation in December, 1949.

This new Gasoline Plant of the Colorado Interstate Gas Company has a capacity of 215 MMCF/day, and operates at 900 lbs. gauge pressure. It effectively removes condensable hydrocarbons that otherwise would seriously reduce pipeline capacity, and guarantees the required heating value of gas into the pipeline. The plant produces specification gasoline.

Operating in connection with the Gasoline Plant is a Stearns-Roger designed and constructed dry dessicant type Dehydration Plant removing water from the gas and insuring against interruptions from hydrate formation.

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These are two of many installations Stearns-Roger has handled for this same customer, and are examples of its complete ENGINEERING-CONTRACTING service available—ONE RESPONSIBILITY within ONE ORGANIZATION.

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1. Back hoe chopping slit in ice. 2. Pipe on river bank is welded, coated, wrapped, and fitted with river weights.

Nature's Forces Put To Work in Winter

River Crossings

5. Operation "duck board." The timbers support back hoe on river ice, only a few feet from open water.

by F. A. Madill*

IMPERIAL PIPE LINE CO., LTD., lets nature help rather than hinder in making river crossings. The way we do this is told in the following discussion:

During the winter, when temperatures in our territory sometimes drop down to 55° F. below zero, the rivers are covered with a layer of ice 1½ to 3 ft. thick. However, everything in the traverse below this layer remains unfrozen.

*Chief engineer, Imperial Pipe Line Co., Ltd., Edmonton, Alta.

First step in making one of these "winter" river crossings consists of stringing pipe, welding, coating, wrapping, and application of river weights on the river ice a few feet from the proposed location (see photo No. 2). The back hoes then start from each river bank and work toward each other chopping a slit in the ice with the teeth of their buckets. And they also dig a ditch on down in the gravel river bed—both things in the one operation (see photos 1 and 3).

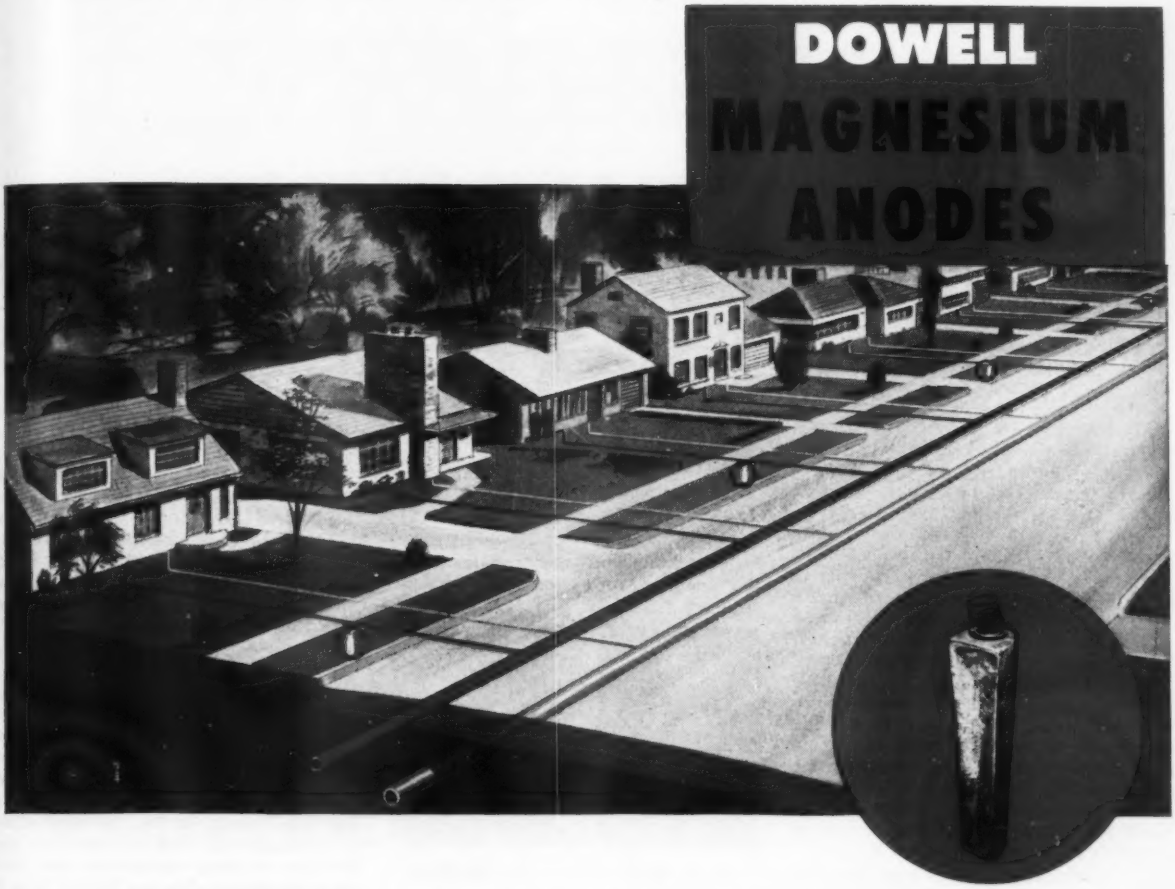
In order to avoid an accumulation of excavated material on the ice next to the slit, which will cause settlement of ice and consequent flooding, trucks are used to transport the material some distance away for disposal (see photo 4). Timbers are laid on the river ice under the back-hoe tracks, which enable a load of from 20 to 30 tons to be safely supported a few feet from open water (see photo No. 4 again). The back-hoe operator pushes the timbers around his machine with the bucket and so advances his "duck board platform" at will, as the digging operation progresses (see photo 5).

When the ditching is completed from bank to bank, side-boom cats lower the pipe through the slit in the ice into the river bed and the river current completes backfilling of the ditch before the spring break-up of ice.

PIPE-LINE Section

3. Trenches dug across river. 4. This is the frozen river, closer view.

Entire municipal piping system protected with



Underground distribution systems can now be protected from corrosion without accelerating metal loss on adjacent structures. Here is a case where leaks were effectively reduced with a low-cost, easily installed system of Dowell Magnesium Anodes.

This was a water distribution system in a municipality of 800 homes. Three years after the water lines were laid down, leaks began occurring rapidly—*18 in a period of three months.* Then Dowell Magnesium Anodes were installed . . . and, in the year and a half after installation, *not a single new leak was reported!* Results like this prove that Dowell Anodes pay! Currently, magnesium anode protection is being applied to the gas distribution system in one of our largest cities.

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2. *Adequate protection without accelerating corrosion on other buried metal structures.*
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4. No outside current required.

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Electric-Arc Welding of Cast Iron

PIPE-LINE Section

The authors describe the technique of making repairs by arc welding, and point out how maintenance can be simplified and costs reduced by good welding practice.

by A. M. Hill, F. W. Zilm, and C. E. Spencer

CAST iron is the basic material used in many types of heavy machinery such as the frames of large diesel engines, pipe-line discharge pumps, compressors, excavating machinery, and the like. Frequently, parts of these machines are subject to failures which are costly to repair by replacements. Arc welding has, in many instances, simplified maintenance and repair of these machines. Long delays due to shutdown time have been avoided. However, this method of repair requires a special technique to control the complex problems of distortion. For these reasons some maintenance supervisors have been reluctant to repair cast-iron machine parts by welding. While it is entirely practicable to arc weld cast iron, there is a wide variation in the quality of cast iron, and its physical characteristics differ considerably from those of cast steel and malleable iron, although the melting points of the three types of metal vary only about 400° F.

Commercial grades of cast iron are low in cost and possess high resistance to compressive stresses. They have higher proportional fatigue ratings than cast steel. The compressive strength of cast iron ranges from 80,000 to 100,000 psi. Castings formed of the material are usually assembled in a machine to take advantage of its high compressive strength. In the repair of cast iron by welding, shrinkage of the deposited metal must be controlled so that the finished weld will be kept in compression by the surrounding metal.

Preparing the Casting for Welding

It is good practice thoroughly to clean the castings by boiling in an Oakite solution, then to check for defects with Magnaflux equipment. In the absence of special equipment, a mixture of plaster of paris will aid in defining the area to be repaired. This mixture is applied with a brush to the broken area and allowed to dry. Minute cracks on the surface not visible to the eye may be found by this method. After locating the end of each fracture, drill a $\frac{3}{16}$-in. hole completely through the casting to check the possibility of the crack extending further while the casting is being prepared for welding.

A. M. HILL

A. M. Hill, line maintenance superintendent of Service Pipe Line Co., has been engaged in welding and pipe-line construction for more than 30 years. During 27 years of employment with Service (formerly Stanolind) Pipe Line Co. he supervised welding; pipe-line construction and maintenance; and the design, fabrication, and installation of manifold piping systems throughout the company's system. He has invented and developed pipe-line tools and equipment, also contributed to the standardization of pipe-line practices, particularly for construction and maintenance of lines and associated equipment.

F. W. ZILM

C. E. SPENCER

F. W. Zilm, welding technician, Service Pipe Line Co., started with this organization in 1933 in Illinois when it was called Stanolind. On receiving the title of welding technician in 1948, he was transferred to Tulsa where he has been concerned with all major construction projects undertaken for the company's system. During World War II he was instructor at the Army's welding school in Nebraska. He headed the Tulsa welding school of the organization now known as Pipe Line Contractors Association.

Claude E. Spencer, consultant, grew up in Freeman, Mo., where he operated the local power plant before being employed at the large nearby junction pump station of Sinclair Pipe Line Co. in 1925. During 23 years of service with this organization subsequently Stanolind Pipe Line Co., now Service Pipe Line Co., he specialized in welding and tank construction and became welding supervisor and tank superintendent. During World War II he was loaned to U. S. Army Engineers as chief welding instructor for pipe-line welding. He is now a consultant for welding and tank service with headquarters in Tulsa.

With a chipping hammer and/or grinder, cut a V-groove in the fracture leaving both surfaces of the groove relatively smooth. The angle of the groove should range from 40° to 90°, depending on the thickness of the metal but should never be greater than necessary for the proper preparation. Groove only to a depth that will insure complete penetration of the coating by the root bead. For example, if the penetration beads in the test coupon show $\frac{1}{4}$-in. penetration, (see Selection of Welding Electrodes) then a $\frac{1}{4}$-in. thickness of base metal should remain in the bottom of the groove. When practical after the welding is finished, the inner surface of the root bead should be chipped or ground out and a finish bead applied from that side. The Magnaflux machine or plaster of paris should be used again after the groove is cut and preparatory to the welding operation, because vibration from the chipping hammer may cause the cracks to extend beyond the end of the groove.

Certain types of steel electrodes have a tendency to separate the carbon from the iron, in the casting, along the fusion zone or surface of the groove causing porosity and brittleness in the root bead with a noticeable loss in ductility. There are two possible methods of eliminating excessive carbon in the fusion zone: (1) Deposit a bead of weld metal using excessive heat which absorbs some of the excess carbon from the base metal. Then follow by chipping out this bead, and grinding away the carbon line. Next deposit a bonding bead with the proper welding heat to insure the necessary penetration. (2) Use a special alloy rod which will absorb and equally distribute the carbon in the fusion zone.

Steel Studs Added for Strength

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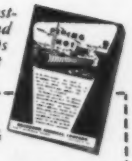

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possible satisfactorily to repair many broken castings without studs. However, extreme conditions usually warrant the use of cold-rolled mild-steel studs which are installed by drilling and tapping the casing along the surface of the groove. The studs should be screwed tightly into the tapped holes at right angles to the walls of the groove to a depth equivalent to the diameter of the studs. The studs are located in a criss-cross position an aggregate of one-sixth to one-third of the total area of the surface to be welded. They should project from ⅛ to ⅜ in. above the surface of the casting. The bottom ends of the studs should be turned or pointed on their ends to an angle of 59°, corresponding with the drill used so that they will bottom up in the tapped hole. This eliminates the possibility of pockets or voids in the casting which would likely trap gas. Care must be exercised in locating the holes to be drilled and tapped, otherwise the casting may be seriously weakened. In drilling and tapping these holes only water should be used as a lubricant, as oil would seep into the pores of the metal and interfere with the welding operation. If the casting contained oil or grease it should be thoroughly cleaned with carbon tetrachloride after welding preperations are complete.

A main-line pump-station engine which was repaired by arc welding. The weld, shown outlined by a white line in the photograph, was approximately 11 ft. long. Thickness of the iron casting is 1½ in.

This cast-iron-base frame of a horizontal-type diesel engine was repaired by electric-arc welding. The finished weld, shown here coated with white chalk, is 4 ft. long.

Selection of Welding Electrodes

Due to a wide variation in the texture and quality of cast iron it is very important that a suitable welding electrode can be selected. This problem of selection requires actual testing of several kinds of electrodes to determine the one most suitable for the job at hand. Procedure for testing electrodes is (1) first clean an area about 1 in. in diameter on the casting, smooth the surface by chipping and grinding. A chart should be provided for recording the following information: Trade name and size of rod tested, polarity, amperage, voltage, number of beads, amount of air pressure used in peening, type of coupon, penetration depth, metal structure, remarks. (2) Test electrode by depositing a series of circular beads at some point on the outer surface of the casting to be repaired but where the testing will not damage the casting, and peen each bead. Deposit successive beads and peen until the weld extends ¼ to ⅜ in. above the base metal (see Fig. 1). After this test specimen has been made, a cold chisel and sledge hammer should be used to break it away from the casting. Then make a careful inspection of the penetration, also porosity of the metal in the fusion zone, and observe other characteristics which conform to the chart.

Selection of the electrode will also depend on the type of welding to be done (1) where the weld is to be water tight select an electrode having shallow penetration, and (2) where structural strength is the prime factor, and electrode that will give deep penetration should be used.

By a series of tests it has been found that the welding electrode which will extract the greatest amount of base metal from a test specimen may make a weld which would contain small check cracks that would leak under pressure, but it also has maximum tensile strength. One manufacturer's electrode will be suitable for certain castings, while others require a different type of electrode.

The character of each electrode thus tested would be shown on the chart so they may be properly appraised after the testing has been completed. This testing procedure will enable the operator to select the electrode most suitable for the casting to be repaired; however, close attention should be given to the directions supplied by the electrode manufacturer. In some cases determined by the tests conducted it is desirable to deviate slightly from the manufacturers recommendations to obtain best results.

Welding Equipment

The engine-driven arc-welding machine is more suitable for cast-iron welding than the electric-motor-driven machine or transformer-type welders. It is essential that the machine be in good operating condition, particularly the generator brushes and the engine-speed governor. It is also desirable to reduce the engine sped about 100 r.p.m. from the normal operating speed. This produces a smoother arc. There is a tendency for arc blow in this type of welding which can be effectively controlled by the use of two ground wires between the machine and the work; by rearranging the grounds occasionally a smoother arc will be maintained. The ground cable must also be firmly attached to the work with a C-type ground clamp.

The proper setting of the welding machine for voltage and amperage is highly important and the directions applying to the type of electrode to be used should be observed; however, the character of the casting may require slight variations from those

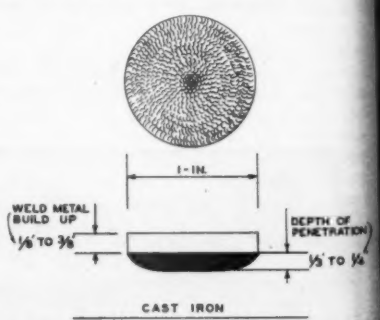

Fig. 1—Test weld. This step is essential to successful welding of cast irons.

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specified by the electrode manufacturer.

Controlling Distortion

Distortion is a prime factor in the repair of cast iron by arc welding, and involves a study of the design, location of welds with respect to thickness of metal, and the sequence in which weld beads may be applied. In welding heavy castings it is possible to alternate the welding from one area to another and thus equalize stresses.

Contraction in Welding Castings

Single cast iron reacts rapidly to slight variations in temperature, provisions must be made to control the contraction throughout the welding operation, and the finished weld must be under slight compression rather than tension. Therefore, contraction must be either calculated or predetermined before welding is started by establishing reference points adjacent to the weld area; then taking accurate measurements across the area to be welded.

The castings, if so designed, should then be expanded by heating with oxyacetylene torches, or by the use of hydraulic jacks, then follow immediately by taking check measurements across the reference points. By this procedure it is possible to determine the amount of expansion that will take place under a given temperature and the results thus obtained should be tabulated, because a certain amount of temperature must be maintained in the welding area throughout the welding operation. The type casting determines the amount of heat for the expansion required. This is covered more specifically hereinafter; however, in welding a large number of castings it has been observed that there is a wide variation in the contraction of cast irons and each type has a different coefficient of expansion and contraction. The average coefficient of expansion is 0.0000056 per °F.; however, castings which are high in carbon and impurities will react differently from the fine grain castings and the amount of expansion may not be in direct proportion to the temperature applied. Castings having a fine grain structure will usually contract more than those having a coarser grain structure.

A wide variation in texture may exist in the same casting—for example, one side may contain iron of fine grain structure while the opposite side may be extremely coarse. This probably accounts for the internal stresses which are characteristic of certain types of castings. If, during the welding operation, a casting contracts more than is desirable, the stresses can be equalized by peening the metal adjacent to the weld.

Welding Procedure

After the step procedures outlined heretofore have been carried out, the welding operation may follow. Where steel studs are used the first step is to deposit a light bead all the way around each stud bonding it to the casting.

At the instant the reddish color leaves the deposited metal the bead should be peened vigorously with a light air hammer, then follow by welding and peening the remaining studs, skipping from one location to another to distribute the heat and thus control contraction. After all studs have been welded, the initial beads, not more than 3 in. in length, are laid in the bottom of the groove peening follows immediately after the reddish color has disappeared. Successive beads should be placed at a different location along the repair and each bead thoroughly peened as described above. Alternating the location of the beads will distribute the heat and counteract contraction stresses. A peening tool measuring ¼ by ¾ in. at the face will suffice for peening all beads as the welding progresses.

After each bead has been thoroughly peened, it must be cleaned with a wire brush before depositing the next bead, removing all slag and scale which could be trapped in the weld casing slag inclusions and voids. The

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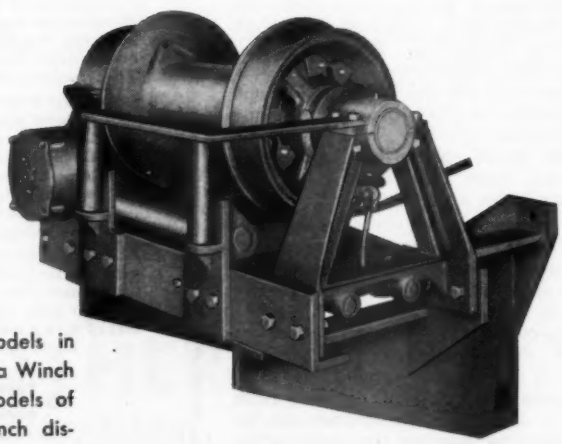

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welder should bear in mind that peening changes the grain structure of the deposited metal, reduces the possibility of chill cracks, expands the area adjacent to the weld, and that all filler beads must be deposited parallel with the fracture. The cover beads may be deposited at right angles to the fracture.

When broken pieces are to be reassembled in a casting, the sides of the pieces which will form the grooves should be bonded with a layer of weld metal preliminary to placing in alignment for welding. This procedure will facilitate peening or stress relieving the metal deposited in the bonding beads.

Welding Cylinder Heads of Diesel Engines

The cylinder heads of large diesel engines usually fracture between intake and exhaust ports and through fuel-injection valve seats, due to accumulations of scale which collect from the cooling water. An approved method of repairing a broken cylinder head follows.

The fracture should be prepared for welding by chipping suitable grooves, installing studs, and establishing reference points on opposite sides of the fracture as explained heretofore. Measurements should then be taken across the reference points while the cylinder head is at normal atmospheric temperature. The head should then be expanded by heating with two welding torches using No. 6 welding tips. Suitable fixtures or stands should be made available for holding the torches in the desired positions. The flames are focused through bolt holes near the perimeter of the head opposite the fracture to expand the perimeter until the distance between the reference points is approximately 0.006 in. greater than when measured at normal atmospheric temperature. The desired expansion should take place when the temperature at the point where the torch flames are applied reaches 350° F.

The heat input from the acetylene torches must be confined to an area approximately 10 in. wide at the perimeter of the cylinder head extending inward to the intake and exhaust ports. Preparatory to starting the welding operation the heating-torch flames are reduced to maintain a temperature of about 350° F. as the temperature in the welding area is further increased by depositing weld beads, consequently particular attention must be given to the heat input from the acetylene torches. Temperatures can be recorded by thermocouples, or suitable thermometers packed in asbestos. Excessive heat will cause too much expansion in the perimeter of the head and may overstress the weld metal deposited in the fracture.

To control expansion, measurements should be taken periodically between the reference points, and should the expansion exceed 0.0065 in., welding operations must be discontinued and the casting allowed to cool to normal atmospheric temperature. Heating torches should then be reapplied and the temperature raised to increase the distance between the reference points to 0.006 in., which should be maintained until the weld has been completed.

Conclusion

In conclusion, it may be pointed out that this procedure was developed by the authors and has been in use generally during the last 12 years by large pipe-line companies. Obviously substantial savings have been effected through the repair of large diesel-engine crank cases, frames, cylinder heads, and other major parts; also the frames and principal parts of oil-discharge pumps. In addition to the savings in direct costs as compared to the replacement with new parts, further savings were realized by eliminating delays which would have occurred in obtaining new replacement parts.

Pipe-Line Lingo

Some nicknames come from the animal kingdom: "River rats" are men working on river crossings; "powder monkeys" handle explosives; a "cat skinner" is a tractor driver.

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For a Short Section of Line

by James F. Stephenson

The application of cathodic protection on 10 pipe lines in the same right-of-way near Gulf's Port Arthur refinery has afforded savings in money, materials and shutdown time. This article gives informative details on the subject

James F. Stephenson was born in Tyler, Tex., in 1918. He first started to work for Gulf Refining Co. in 1936 working summers while attending Texas A. & M. College, finishing in 1942 to serve 49 months in the Army Corps of Engineers. He returned to work with Gulf in 1946.

PIPE-LINE Section

THE Houston Pipe Line Division of Gulf Refining Co. laid the first line into the Port Arthur refinery way back in 1907. There are currently 10 lines serving the refinery. Six of these are 8-in. lines and four are 10-in. lines.

Cross Marshy Area

The area that the pipe lines cross just north of the refinery is low, marshy, and subject to sea tides. The pipe life in this 3.5-mile section was very short and the leak frequency was so great that repair gangs were kept busy repairing the seven lines in service during the period 1926-1936.

The maintenance cost was so high on this section in comparison to other sections that management requested that a survey be made to see if cathodic protection could reduce the number of leaks and extend the pipe life to a reasonable length of time.

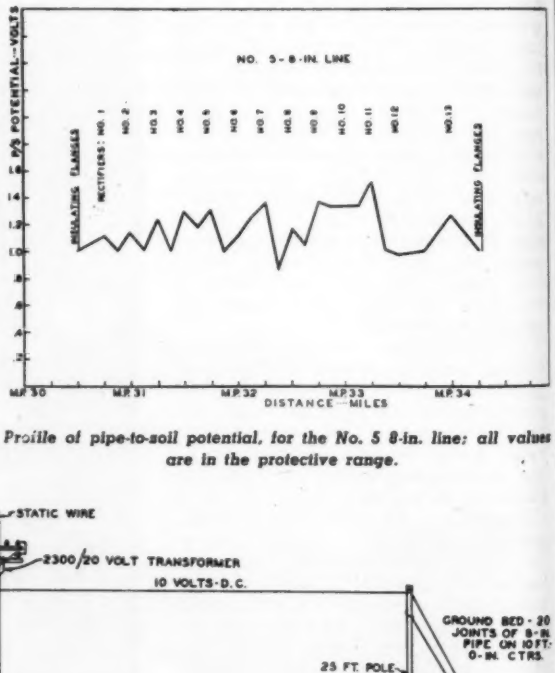
The corrosion survey consisted of long line current measurement and pipe-to-soil potential along the pipe lines to be protected. Due to adverse conditions of the marsh, the pipe lines were put on a levee through the worst part of the marsh. This required the laying of the lines rather close together as is shown in the typical installation sketch.

First Installation

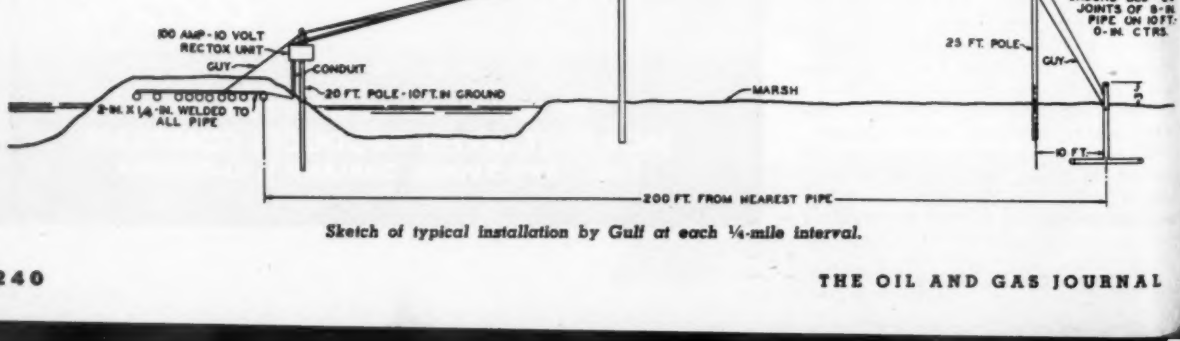
The installation of the cathodic-protection equipment and other pertinent apparatus was begun in March 1936. The cathodic-protection system designed to protect the 3.5-mile section of bare pipe lines (totaling seven) and give a current density of 2 ma. per square foot of metal to be protected, required twelve 100-amp., 10-volt rectifiers. These rectifiers were placed ¼ mile apart since the last ¾ mile was not to be protected at this time due to the indefinite location of a new highway crossing.

All of the pipe lines were bonded together at the rectifiers and midway between the rectifiers. In order to obtain power for the rectifiers, a three-phase, 2,300-volt power line was constructed along the pipe-line right-of-way. (See typical installation sketch.)

The anode system or ground beds consist of 20 joints of 8-in. junk pipe buried in the marsh. There was ample supply of this junk pipe on hand due to the short life of pipe prior to protection. Insulating flanges were installed in each line at the end point of protection. These flanges were lo-



Profile of pipe-to-soil potential, for the No. 5 8-in. line; all values are in the protective range.


2300 VOLT - 3 POWER LINE
35 FT. POLES - 24 PER MILE
STATIC WIRE
2300/20 VOLT TRANSFORMER
20 VOLTS - A.C.
10 VOLTS - D.C.
GROUND BED - 20 JOINTS OF 8-IN. PIPE ON 10 FT. 0-IN. CTRS.
100 AMP - 10 VOLT RECTOX UNIT
GUY
CONDUIT
25 FT. POLE
20 FT. POLE - 10 FT. IN GROUND
MARSH
8-IN. X ¼-IN. WELDED TO ALL PIPE
10 FT.
200 FT. FROM NEAREST PIPE

Sketch of typical installation by Gulf at each ¼-mile interval.

cated in an open ditch above normal water line.

The protection system was put into operation in the early fall of 1936. The average d.c. reading on the rectifiers was 96 amp., and the average d.c. voltage was 9 volts. It can be seen that the internal circuit resistance is less than 0.1 ohm.

In August 1946, the protection was extended to the refinery manifold. This required the addition of one rectifier, ground bed, and 7/10 mile of single-phase power line. The insulating flanges were moved to an overhead bayou crossing adjacent to the refinery fence.

A typical value of the pipe-to-soil potential (using a copper sulfate electrode) is shown in the graph of the No. 5 8-in. line. Even though the voltage varies from 0.86 to 1.56 volts, all values are in the protective range.

Cost and Protection

The leak records reveal that there were 307 leaks in the seven lines that were present in the 10-year period prior to protection. The maintenance cost for these lines for the 10-year period was $117,000. There have been 72 leaks in the 13 years since protection has been applied. It should be pointed out that 51 per cent of these leaks occurred in the first 2 years after protection was applied, indicating that the rust holes were present prior to the time that protection was applied. The maintenance cost of the pipe lines in the first 10 years was $11,000 for the 3.5 miles under cathodic protection. There have been no leaks in the three pipe lines that have been laid since cathodic protection was applied.

The cost of the cathodic protection equipment, the installation thereof, power for the equipment, and maintenance for the 10-year period was $20,460.

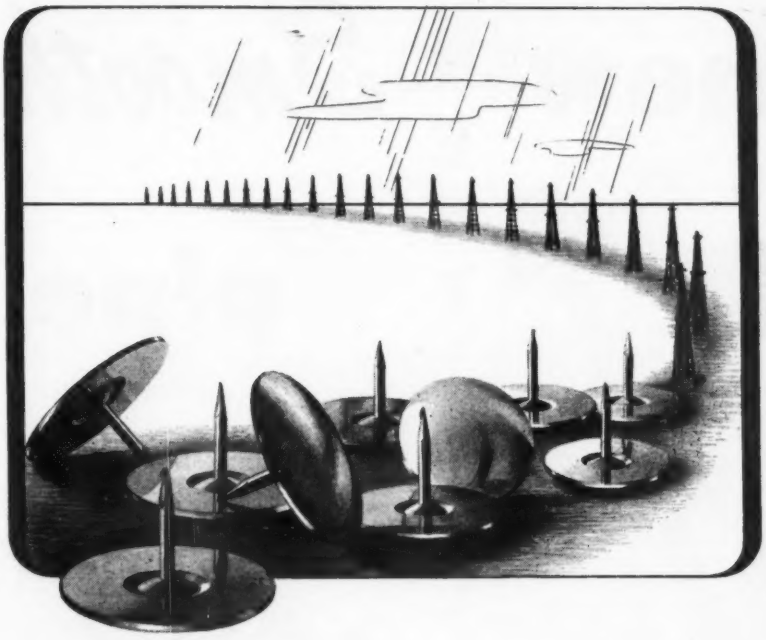
Conclusion

In conclusion, cathodic protection on the pipe lines in the area 3.5 miles north of the refinery has saved this company a net amount of $85,540 in the first 10 years that it has been in use.

Pipe-Line Lingo

When a pipe liner is hired he "sets in" if he is fit and ready he is said to be "work ways;" if physically unable he is "burned out;" if qualified for a better job he "breaks out;" when he quits he "drags up." After being hired, if he hasn't enough money to live until payday, he may get "walking around money" as an advance from the contractor.

Since skilled jobs go with mechanical equipment, hand tools are not so popular; a shovel is an "idiot stick;" a hoe is a "mud hook;" shoveling loose dirt out of the ditch is "crumbing out."



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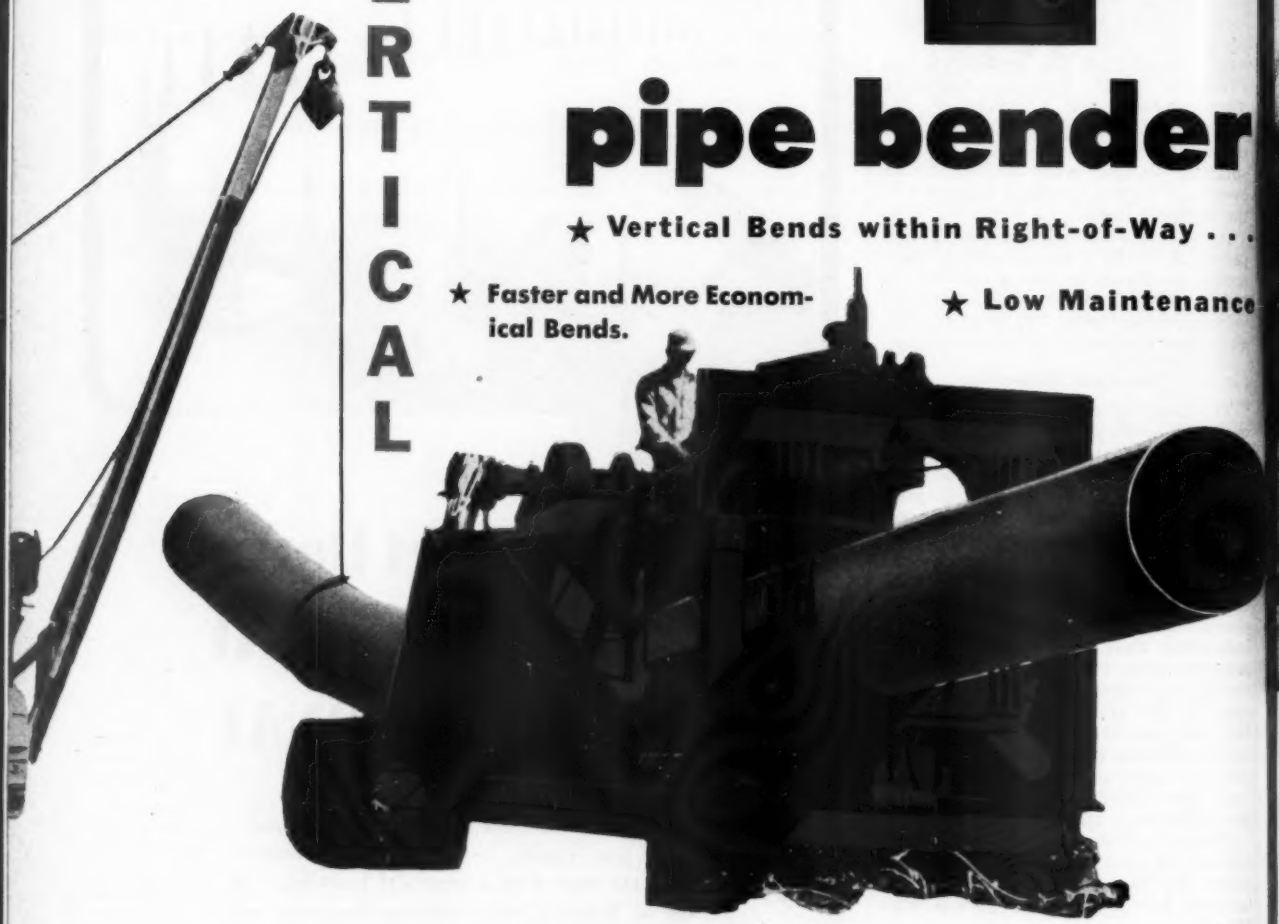

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★ Easily transported by truck.

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★ Superior strength . . . light weight (25,000 pounds including Athey Tracks).

★ Machine Cost: $10,500 with Athey Tracks f.o.b. Houston.

★ Low bending shoe rental rates.

DIMENSIONS:

Width with Tracks	8′ 11″
Width less Tracks	7′ 6″
Height with Tracks	9′ 9″
Height less Tracks	8′ 7″
Length	23′

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CAPACITY:
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GENERAL DIMENSIONS:
Overall width, 10' 5½"
Height from G/L, 13' 4½"
Traveling length, 48' 8"
Width over crawler, 10' 5½"

CRAWLERS:
Caterpillar D7's, 24" wide

POWER UNIT:
Caterpillar D13000,
H.P. 110 @ 850 R.P.M.

FRONT WHEEL:
Steered hydraulically by hydraulic motor with worm and worm gear enclosed, running in oil.

EXCAVATOR WHEEL HOIST:
Front and rear excavator wheel hoist as well as conveyor hoist hydraulically driven enclosed in single case, running in oil.

EXCAVATING WHEEL:
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SEGMENT GEARING:
American Manganese Steel. Normal Speed of digging wheel at rooter points, approximately 248' per minute.

CONVEYOR:
Removable sections for narrow or wide buckets. Width of belt, 36". All inner and outer belt pulleys anti-friction bearings. New type silent center belt guides. Conveyor driven independent of digging wheel by hydraulic motor allowing any variable speed of conveyor belt.

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Atlantic's West Texas-Gulf Line

. . . Its Design and Construction

PIPE-LINE Section

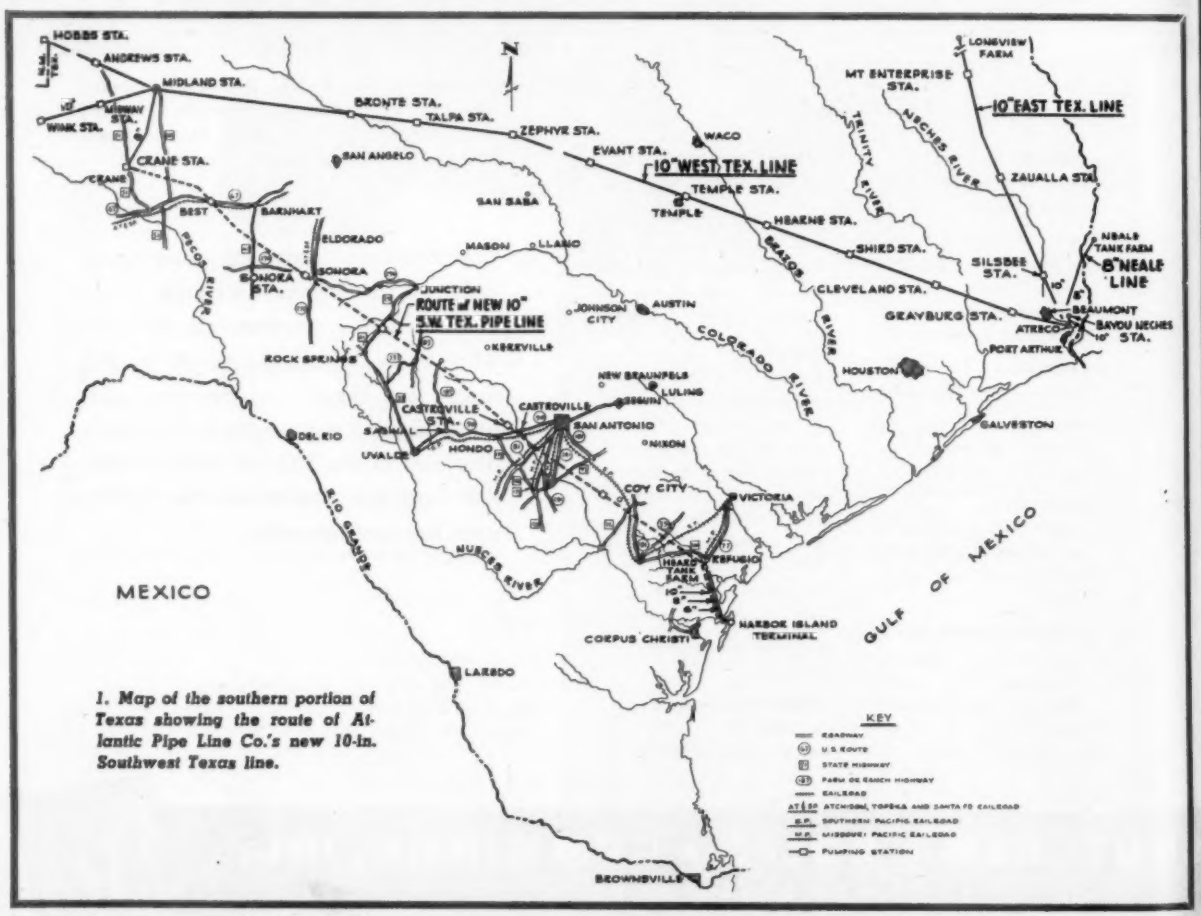
by Lester M. Goldsmith

AS early as 1946 Atlantic Pipe Line Co. had laid plans for increasing its capacity to move crude out of the West Texas area and early that year had placed a mill order for 10-in. pipe with the original intention of looping an existing 10-in. line between Midland and Port Arthur, as shown by Fig. 1. This crude would then have been available to Atlantic's Port Arthur refinery and for transshipment to tankers at the company's marine terminal on the Neches River.

The project lay dormant until the fall of 1948, due principally to the lack of crystallization of plans and to the inability of the pipe mills to promise firm delivery dates. At that time the mills served notice that if Atlantic wished to retain the order it would be necessary to accept immediate delivery of the pipe.

Meanwhile, consideration had been given to selecting an alternate route to the Gulf Coast where terminal facilities would be available. The company possessed a marine terminal at Harbor Island, near Port Aransas, Tex., which had pipe-line connections to its Heard tank farm and pumping station, approximately 30 miles inland, near Refugio. Although it was realized that the construction of a line from the Midland area to Refugio would present considerable con-

Lester M. Goldsmith is vice president and chief engineer of Atlantic Pipe Line Co. He is a graduate of Drexel Institute of Technology, which institution awarded him the honorary degree of doctor of science. He was the original chief engineer of the WEP lines, and participated in operations "Pluto," by which flexible pipe lines were successfully extended across the English Channel during World War II, for which he was awarded the Exceptional Civilian Service Medal.



1. Map of the southern portion of Texas showing the route of Atlantic Pipe Line Co.'s new 10-in. Southwest Texas line.

The Solution...a 9-Ton GERLINGER Lift Truck!

A tricky handling problem had contractors on the world's largest natural gas pipe-line job in California scratching their heads recently. The multiple operation involved unloading 30-ft. sections of 34-in. steel pipe from trucks, holding these sections in place for welding, loading 90-ft. sections on trucks and installing them in alignment on various job sites. Old-timers termed the job "Operation Impossible"—until a 9-ton Gerlinger PH 962 Lift Truck, equipped with a Gerlinger Hydraulic Grab Arm, was put to work.

Working in soft sand and mud most of the time, the Gerlinger is successfully handling all phases of this loading assignment . . . and doing it faster. Gerlinger power—plus the labor-saving Grab Arm—is particularly proving its versatility in loading and unloading the 90-ft. pipe sections, weighing 18,880 lbs. . . . and placing them in exact alignment for welding.

Again—a Gerlinger all-purpose Lift Truck saved the day for an owner with an unusual handling problem!

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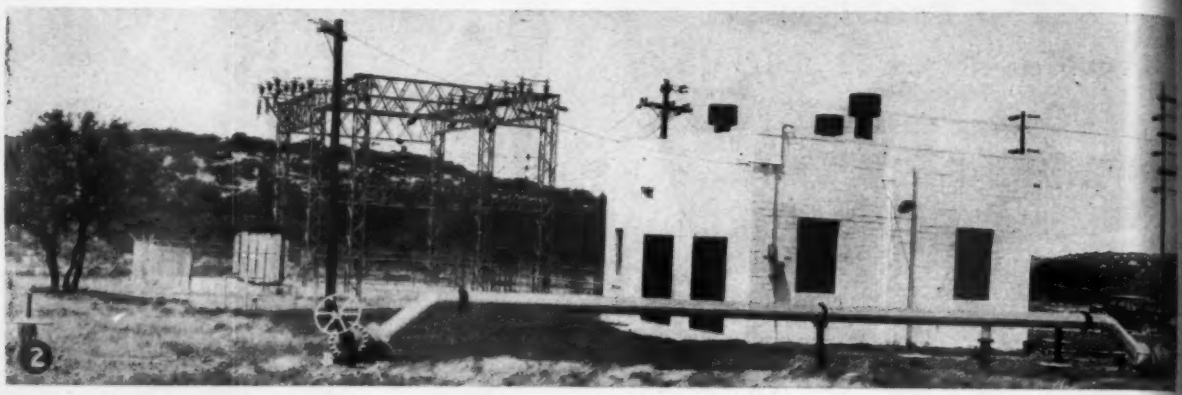


2. Atlantic's Sonora intermediate pumping station on the new 10-in. Southwest Texas pipe line, viewed from north.

struction difficulties due to the rough terrain which would have to be traversed, this possibility provided the shorter distance which Atlantic was seeking. In addition to the savings that could be effected in the purchase of the pipe alone, other factors, including cheaper pumping costs and the advantages of a second deep-water terminal from which to transfer crude, weighed heavily in favor of the alternate route. Further, company production experts felt that there was a reasonable expectation of new production being discovered in the proposed area which would provide a source of potential business. Therefore, in the fall of 1948, when the pipe became available, the company had finally decided on the alternate route. With this decision, the Crane pumping station in Block 31 field, which was serving as a feeder to Atlantic's Midland-Port Arthur system, became the terminal station for the new line. The Midland farm then became a feeder station for the new main line and it became necessary to reverse the direction of the flow through the 47-mile section of the existing 8-in. line between Crane and Midland.

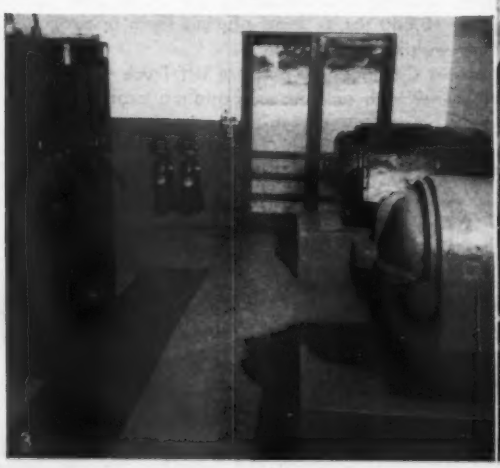
The major problems then became the laying of approximately 383 miles of line required to connect Crane and Refugio stations, of modifying the pumping facilities at the existing stations at Midland, Crane, and Refugio to permit their operation in the new main line, and of constructing the new intermediate pumping stations and their appurtenant facilities. Further, to increase the flexibility of the various stations and their ability to handle the various grades of crude in the West Texas area, it was necessary to install additional tankage at Crane, Refugio, and Harbor Island. The total tankage requirements were two additional 80,000-bbl. tanks at Crane, three additional 80,000-bbl. tanks at Refugio, and two additional 80,000-bbl. tanks at Harbor Island.

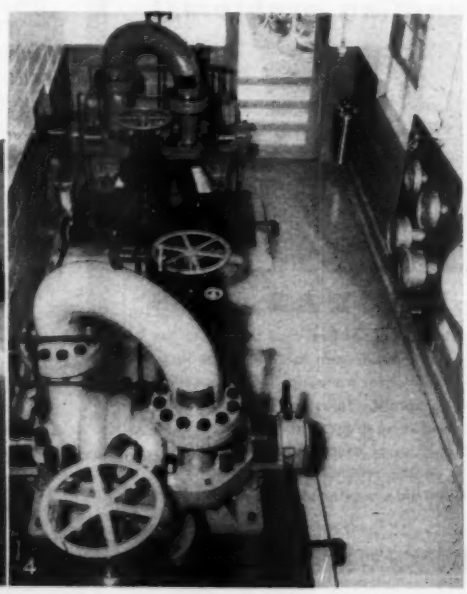
The new line was originally designed to handle approximately 23,000 bbl. per day by the operation of a pumping station at Crane only. However, by the time construction got under way, the Silsbee and Mt. Enterprise stations on Atlantic's East Texas line were no longer required, and by transferring the pumping equipment from these two stations to the company's new line at Castroville and Sonora it was possible to raise the capacity of the line to 33,000 bbl. per day. Future plans contemplate an ultimate capacity of 50,000 bbl. per day by the installation of additional intermediate stations.

5. Cottage for operating personnel at Sonora station.

3. Motor room of the Sonora station.

4. Pumping equipment at the Sonora station on Atlantic's new pipe line.





Present and projected pumping requirements at the various stations are as follows:

1. Midland. — Here there is presently installed a centrifugal pump driven by a 200-hp. 3,600-r.p.m. electric motor which is capable of delivering 16,000 bbl. per day to the Crane station. Steps are being taken to raise pumping capacity to 26,000 bbl. per day by the installation of a 600-hp. 3,600-r.p.m. constant-speed motor

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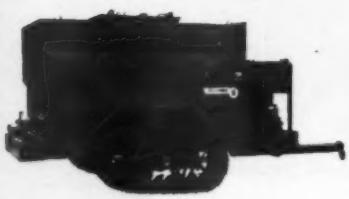
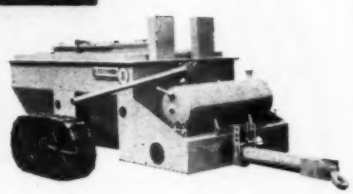


30 BARREL CAPACITY

23 BARREL CAPACITY

CROSE-LITTLEFORD PIPE COATING KETTLES are equipped with hydraulically controlled agitator, low pressure burner, dial-type thermometer and a Wisconsin air-cooled gasoline engine with electric starter. If the agitator becomes fouled, the hydraulic fluid by-passes until the agitator is freed. The low pressure burner uses any type of low-grade fuel oil and distributes heat equally over all parts of the bottom. This burner is designed to avoid hot spots thereby eliminating the necessity of replacing bottoms. These completely insulated kettles may be purchased on Athey tracks or on skids for stationary coating yards. Over 150 of these kettles are in service in the United States and Canada.



10 BARREL CAPACITY

CROSE-LITTLEFORD PIPE COATING KETTLES are equipped with manually operated agitator, two No. 5 burners and can be furnished mounted on Athey tracks or skids. This kettle also available with hydraulically controlled agitator and Wisconsin air-cooled engine. This kettle has been proven in field service.

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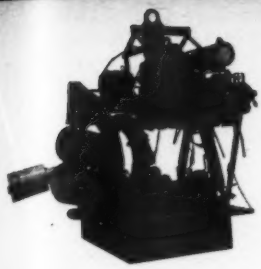
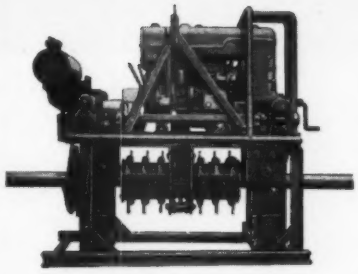
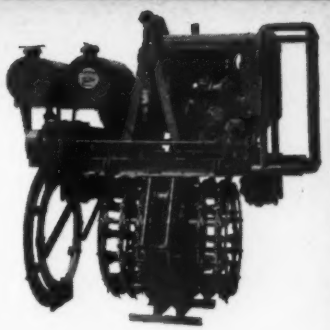


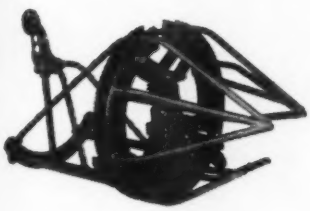
The 22" - 26" Crose line-traveling coating and wrapping machine. These machines are available for coating and wrapping pipe sizes from 2" to 34" in diameter. The positive application of coating through our patented coating spray ring gives these advantages: 1. Coats bends as well as straight pipe. 2. Applies coating to pipe that has been "egged" or bent out of shape. 3. Reduces patches on bends to absolute minimum.



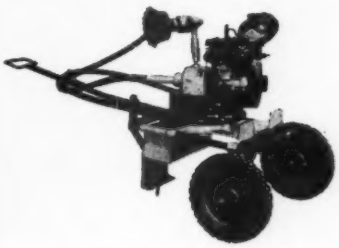
MODEL "M" PIPE CLEANING AND PRIMING MACHINE can be set up to clean and prime pipe from 2" to 14" in diameter. May be used as a line-traveling machine or on a stationary base for yard work.



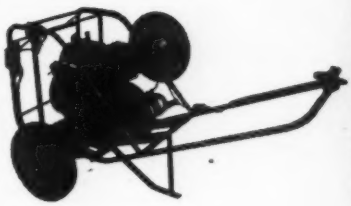
MODEL "K" PIPE CLEANING AND PRIMING MACHINE can be set up to clean and prime pipe from 16" to 26" in diameter. May be used line-traveling or on stationary base. This machine is also available for larger pipe sizes.



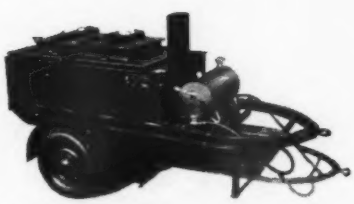
CROSE INTERNAL LINEUP CLAMPS are available in manual, electric and hydraulic models for pipe sizes ranging from 12" to 36". Crose Internal Lineup Clamps have been proven in world-wide field operations.



CROSE PORTABLE BUFFING UNIT is used to operate sanding discs or wire wheels for cleaning stringer beads or pipe bevels.



1500 WATT SELF PROPELLED GENERATOR is a utility unit for operating wire brushes, buffers and cleaning bevels. May be used as utility light plant.



225 GALLON PATCH KETTLE is equipped with manual agitator. Available as illustrated or on steel wheels. These units are now being used for patch work and maintenance on pipelines. This unit also available in 165 gallon capacity.

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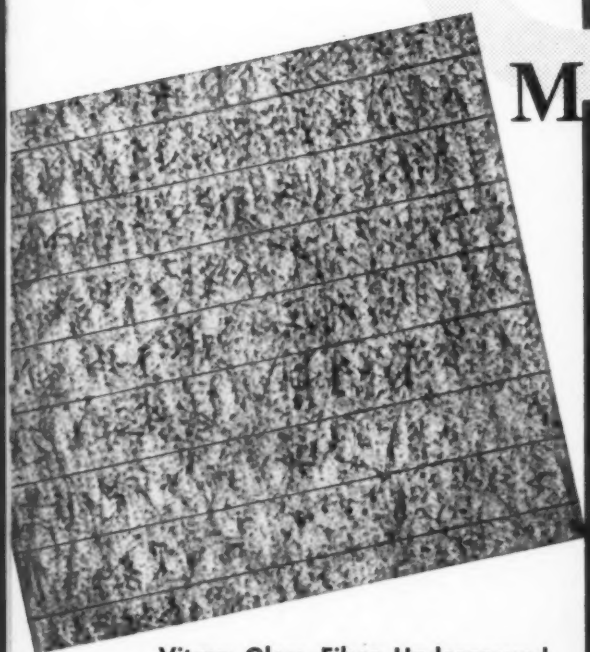

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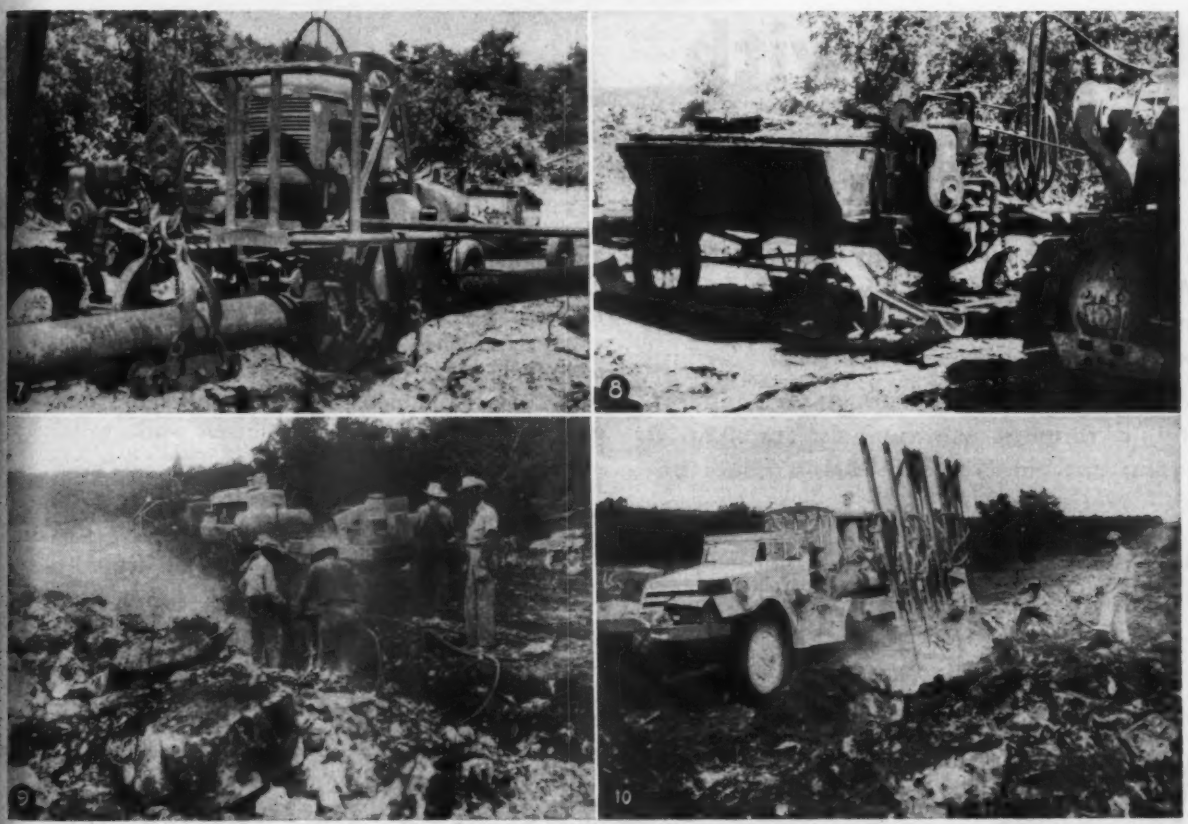
6. General view of dissected plateau area encountered in building Atlantic's new 10-in. pipe line in Southwest Texas.

and by the installation of a new pump rotating assembly.

2. Crane.—Main-line pumping equipment at this station now consists of two four-stage centrifugal pumps, operating in series, each driven by a 600-hp. 3,600-r.p.m. constant-speed motor. The impellers in these pumps have a maximum capacity of 33,000 bbl. per day, but by the installation of larger impellers they will be suitable for handling 50,000 bbl. per day. As previously indicated, when the present intermediate stations at Castroville and Sonora are idle the Crane pumping equipment is capable of delivering 23,000 bbl. per day to Refugio. With these stations in operation the capacity can be increased to 33,000 bbl. per day.

3. Castroville and Sonora.—These intermediate stations were installed as part of the original construction. The idle pumping equipment which was transferred from the East Texas line to these stations consists of two centrifugal pumps, operating in series, each driven by a 350-hp. 3,600-r.p.m. constant-speed motor. However, when it becomes necessary to increase capacity to the ultimate, larger pumps must be installed, driven by 600-hp. motors. As a matter of interest, power for the East Texas stations is generated with the company's own diesel-electric plants.

4. Refugio.—Here it was necessary to install an additional centrifugal pump driven by a 300-hp. 3,600-r.p.m. constant-speed motor in order to deliver 33,000 bbl. per day to Harbor Island. The existing 6 and 8-in. lines from Refugio to Port Aransas were in poor condition and it was doubtful as to whether or not they would withstand the additional pressure required by the higher pumping rate. Consequently, it was deemed advisable to parallel the old lines with a new 10-in.



7. Coating machine used on Atlantic Pipe Line Co.'s new 10-in. line. 8. Modified doping pot for applying special coating material. 9. Crew and equipment for hand jack-hammer operation. 10. Drilling rig No. 1 is mobilized with a modified army half-track unit.

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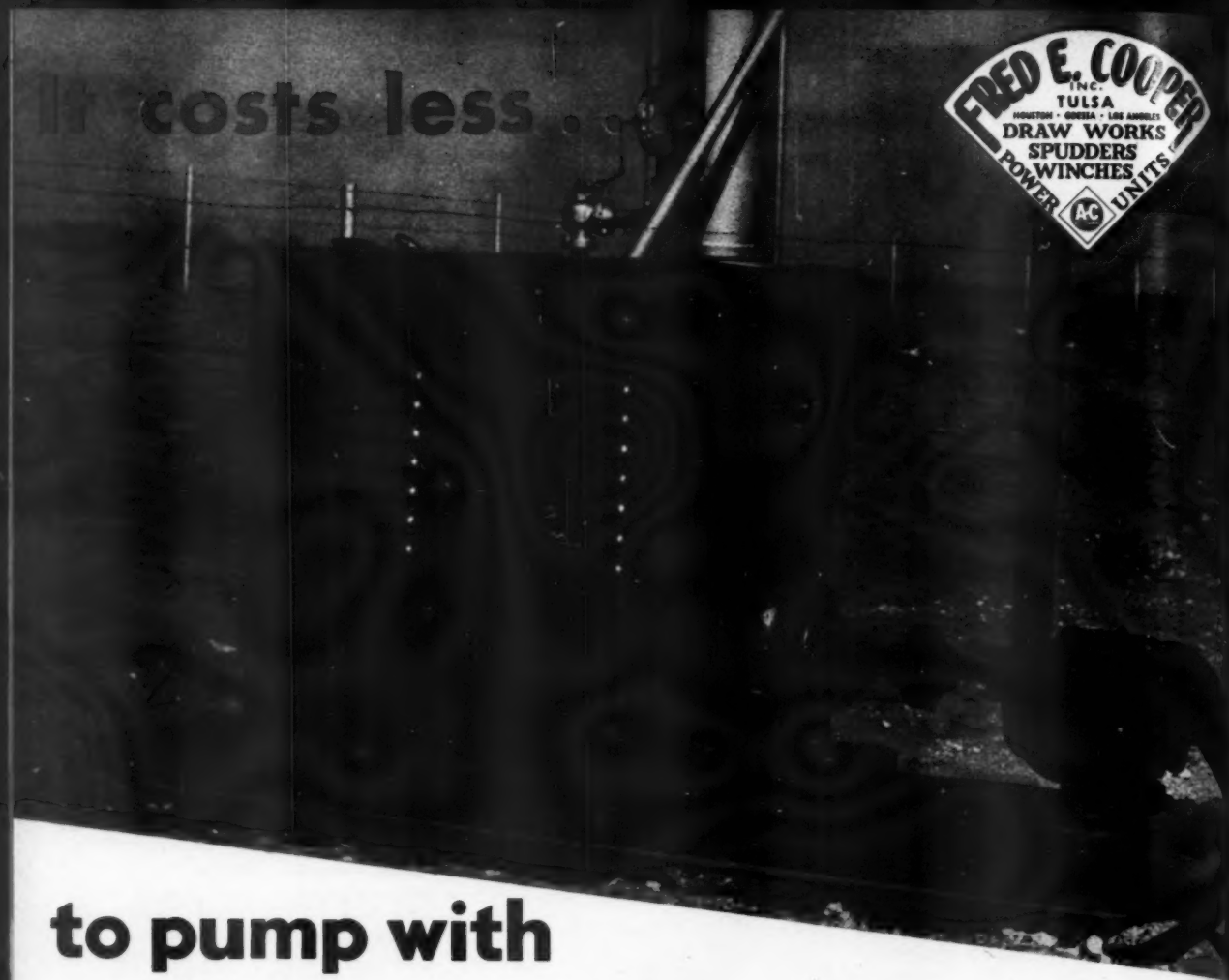

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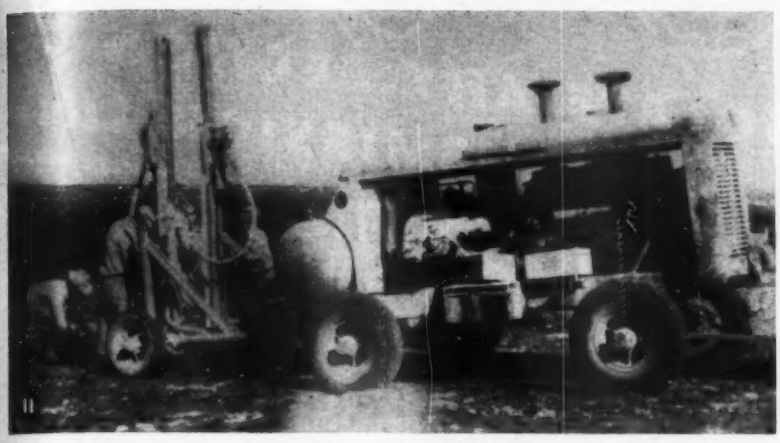


11. Mobile drilling rig No. 3

line between the points indicated. To reach the ultimate capacity of the line will require the installation of additional pumping equipment which will be identical to and in series with the pump presently installed.

For the construction of the intermediate stations a concrete block building with concrete floor and a poured concrete roof was selected. Inasmuch as the terminal stations at Crane and Refugio were only slightly modified, no comment on the building construction at these stations is warranted, but since the intermediate stations were designed as a part of the project, attention is given to them. Figs. 2, 3, and 4 show an exterior view of the building and interior views of the motor and pump rooms, respectively, at the Sonora station. In the company's opinion these pumping stations are functional, economical, and well suited for their purpose and location. Company engineers purposely tried to get away from the large buildings which are ordinarily associated with such stations. Due to the isolated locations of the stations at Sonora and Castroville it was found necessary also to construct living quarters for the chief operator. For this purpose a frame cottage, illustrated in Fig. 5, was selected.

In addition to the main pumping equipment indicated above, centrifugal boosters were installed in the tank farms at Midland and Crane to insure positive suction pressure on the mainline centrifugals when they were pumping at full capacity.

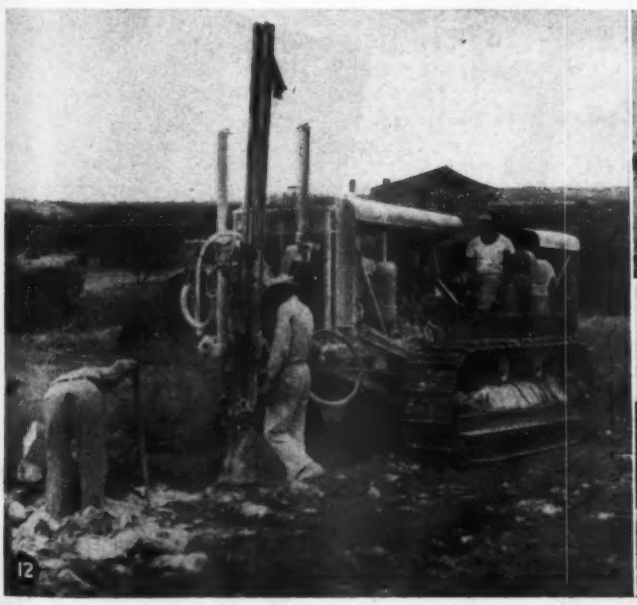
The line from Crane to Refugio can be operated as a closed system, and for this purpose 10,000-bbl. station tanks were installed at Sonora and Castroville. These tanks are connected into the main line ahead of the station suction. A relief valve in this line relieves the main stream into the station tank when the suction pressure builds up by a surge which may be caused by emergency station shutdowns due to power failure. In addition, these tanks are valuable in maintaining a more constant capacity through the line since they are used to receive oil when the downstream stations are down or to deliver oil to the line when the upstream stations are offstream. All stations on the new line are electrically operated with power furnished directly from the substation owned by the utility company serving the area.

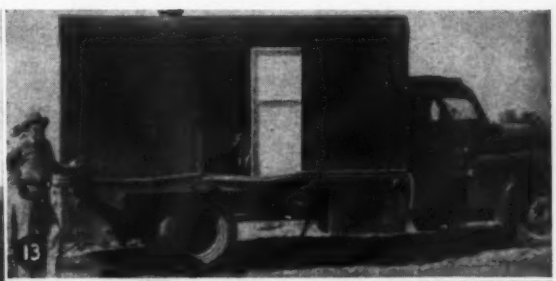
With final adoption of the Crane to Refugio route, selection of a right-of-way became the matter of primary importance. The general terrain between these points can be classified as follows:

1. West Texas level tableland.—Here there is considerable rock and caliche underlying a shallow soil mantle but, except for hard ditching efforts at times, this country, with its flat or gently rolling surface, makes for easy pipe lining.

2. Dissected plateau merging into tableland.—Terrain of this kind lies above Sonora and had to be crossed by the proposed line. This area is full of box canyons, escarpments, and steep slopes, and the best that can be done with any alignment is to take advantage of local conditions. Across

12. Tractor-mounted No. 2 drilling rig. 13. The enclosure on this truck houses steam-generating equipment used to avoid bitter weed contamination of free grazing areas. 14. Backhoe operating on rough ditch.





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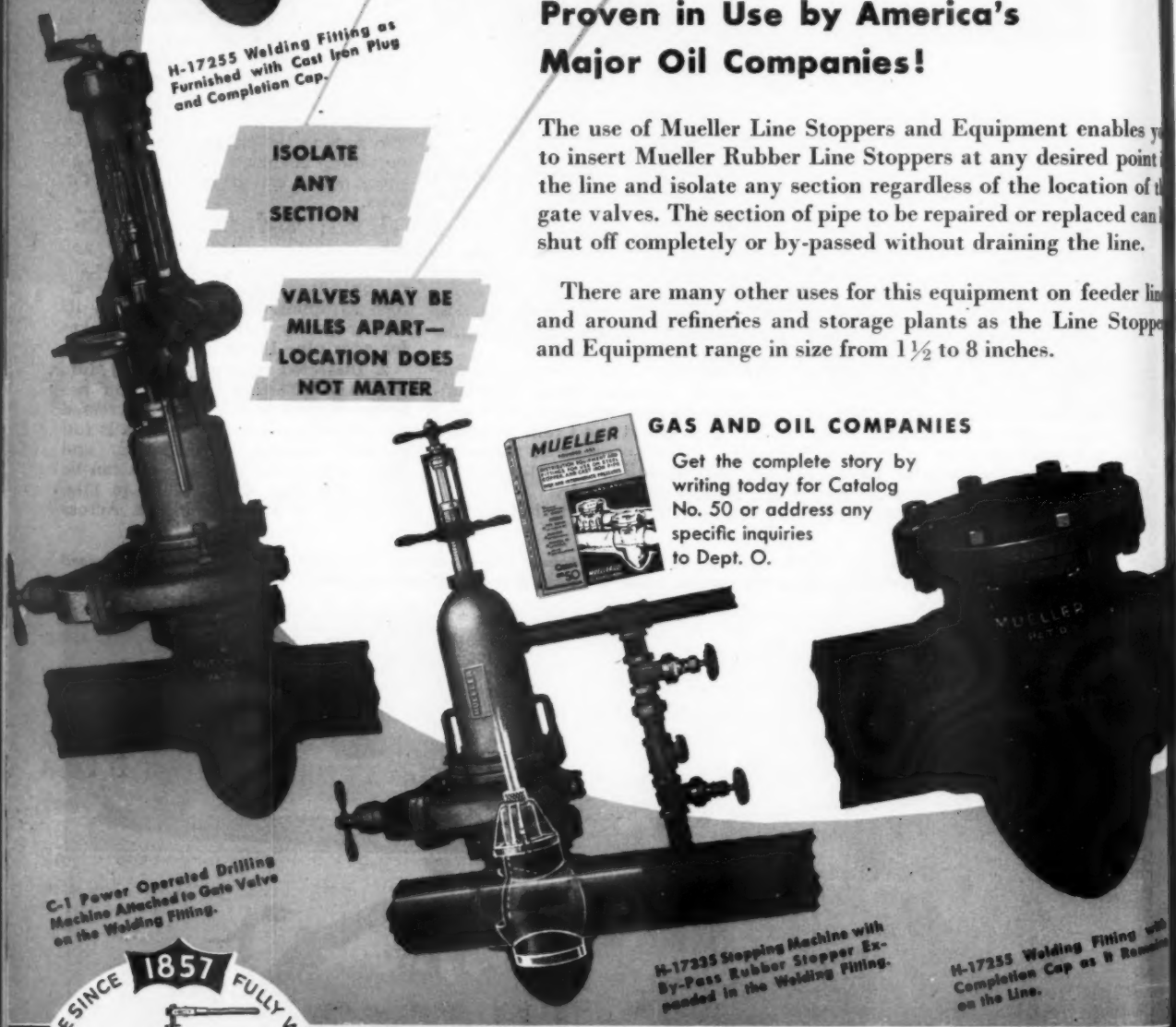

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this area it would be necessary to run a rock ditch almost continuously. (See Fig. 6.)

3. Coastal plains.—Terrain of this nature runs generally south of the dissected plateau country, commencing at a point west of San Antonio and extending to the gulf. Terrain in this area is ideal for pipe lining.

The right-of-way problem resolved itself into crossing the dissected plateau country at its narrowest point without lengthening the line. General knowledge of the country, furthered by field reconnaissance, led to the selection of a general route. An aerial flight strip course was then flown over the proposed route. This route looked promising enough to permit establishment of control points and to lay out the line on the aerial photographs. Where terrain appeared particularly rough a stereoscopic examination of overlapping photographs was made to determine the best course for the line. In the spring of 1948 the author and the general manager of the company made a personal reconnaissance of the tentative route, by plane, and approved its use.

The sudden development in the pipe situation made it necessary to complete the ground survey and to stake the line. In October 1948 a contract was let to Burlesson & Garrett Engineering Co., Dallas. This survey commenced November 3, 1948, and was completed in April 1949.

Upon completion of the survey, representatives of Atlantic's construction division and land department went over the surveyed route with the surveyors for the purpose of altering the alignment where necessary to avoid difficult terrain obstacles, stock tanks, ranch houses, airports, and to change alignment for approaches to railroads and highways. The minor nature of the changes involved attests to the care which was given in the final selection of the route and the reliability of aerial photography for such work.

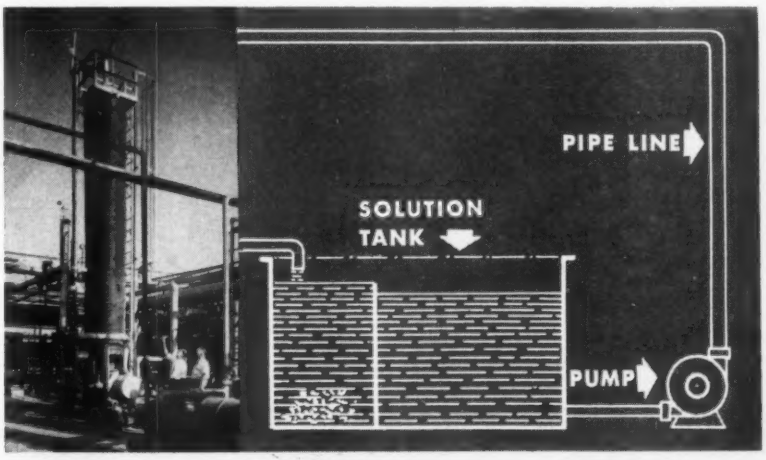
For construction of the line 10¾-in. o.d. 0.307-in. wall-thickness, (34.24 lb. per foot), seamless steel, A.P.I. Specifications 5-L, Grade B line pipe was selected. The pipe was delivered in double random lengths, varying in length from 38 to 44 ft., but averaging not less than 40 ft. Previous experience indicated that the best welding results could be obtained if the maximum carbon content (ladled) did not exceed 0.30 per cent. The pipe was also delivered with beveled ends having $\frac{1}{16}$-in. land. The specified minimum tensile strength was 60,000 psi.

In the main run of the line from Crane to Refugio, river crossings were of minor consideration. For the few encountered 10¾-in. o.d. 0.500-in. wall-thickness, (54.74 lb. per foot) seamless steel line pipe, A.P.I. Specifications 5-L, Grade B, was specified. It may be interesting to note that on the Refugio-Aransas Pass section of the line it was necessary to cross approximately 5 miles of marsh land and a short section of Copano Bay. For these crossings it was also decided to use the heavier-weight pipe in lieu of line clamps. Consequently, no line clamps were used in the construction of the line.

To insure that the pipe would remain free of foreign matter during transit, storage, and stringing, each end of the pipe was fitted with a "Van Dyke" protector consisting of a pressed-steel cap placed over the open end of the pipe and spot welded to it. This cap was not removed until after the pipe had been strung and just before it was welded into the line. As a matter of interest, this cap was patented by and gets its name from the late J. W. Van Dyke, former chairman of the board of Atlantic Refining Co.

Except for certain highly corrosive areas, such as that encountered in crossing Big Lake oil field and other local areas, the company elected to treat the general run of pipe with a protective coating to inhibit rust. Based on experience in the protection of underground lines at company terminals and refineries and on all-welded steel docks, a coal-tar reagent marketed under the trade name Farbertie, was specified.

In connection with the application



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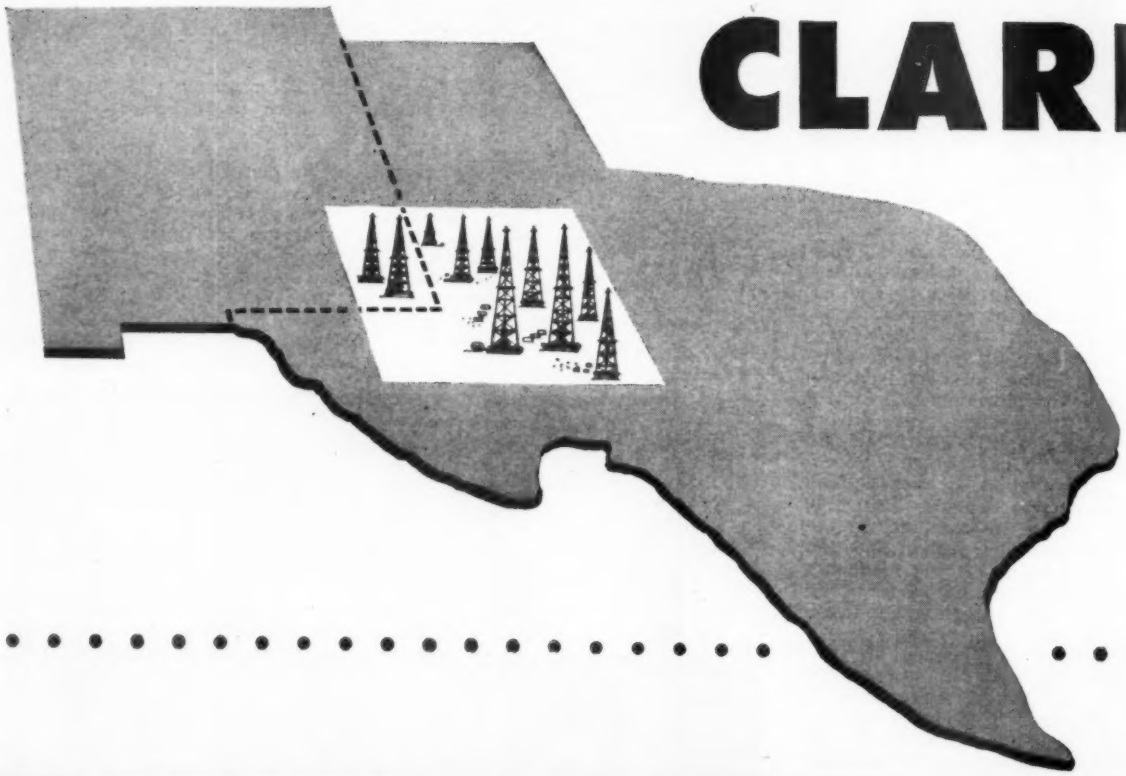

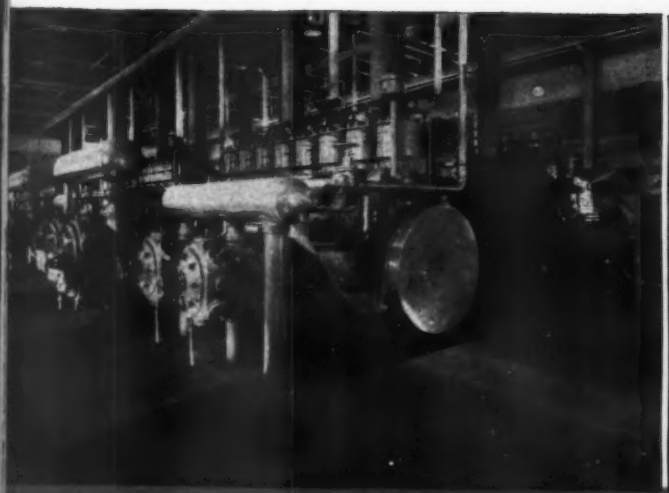

Wasson No. 2—part of Clark RA-8 installation totalling 19,200 BHP at Shell Oil Company's Wasson No. 2 plant.

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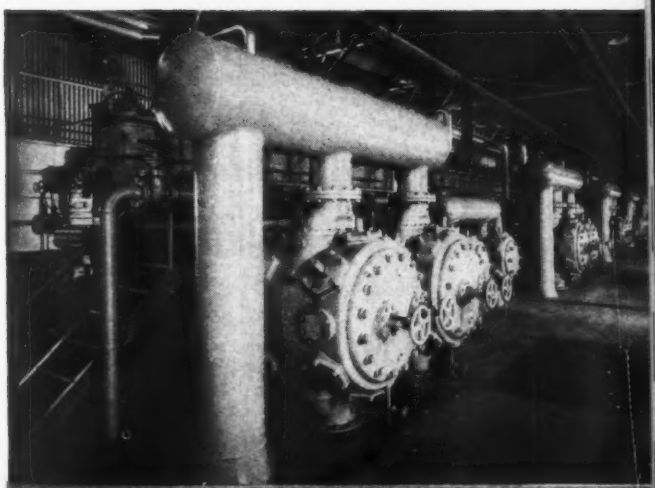

Ector County, Tex.—Clark RA-8 compressors, part of 17,600 BHP installation at Shell Oil Company's TXL plant.

Monument, N. M.—8600 installed BHP of Clark RA-4 and RA-6 units at Warren Petroleum's plant.

South Fullerton Gasoline Plant—operated by Stanolind Oil and Gas Company.

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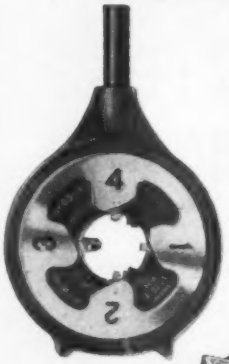

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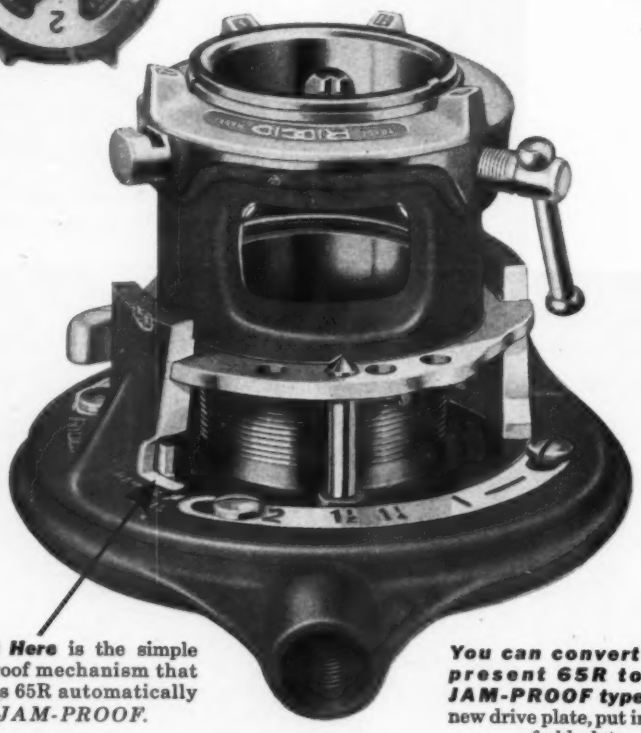

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of this material, experience had demonstrated that if a common gear pump were used to provide constant recirculation of the material through a dope pot it could be kept in a liquid condition, permitting it to be sprayed or pumped. Consequently it could be used with a standard cleaning machine. Since this material could be applied without heating, and could be used with standard pipeline equipment, it was selected for this application.

However, prior to this time Farbertie had never been used on a long line and it was necessary to devise a gadget for its application. The application device consisted of a sheet-metal sleeve clamped around the pipe, which in turn was attached directly behind the cleaning machine. Into this sheet-metal sleeve was riveted a piece of ordinary carpet or rug which overlapped the pipe and was gripped to it by the sleeve. During the early trials it was found that proper application of the material required a section of rug about 40 in. in length, part of which trailed the sleeve. Ordinary door screen was found best for maintaining proper tension between the rug and the pipe on the trailing portion. The coating material was pumped into a reservoir within the sleeve, the forward motion of the device over the pipe completed the application. Actually, the device was the result of "go-or-no-go" experience, but within a short time satisfactory results were being obtained. For the general setup of the applicator see Figs. 7 and 8.

For corrosive areas and marsh crossings between Refugio and Port Aransas, the line was primed with conventional pipe-line enamel and was then hot doped and double wrapped, using one layer of fiber glass and one layer of asbestos felt. For river crossings and other areas where the pipe had to be dragged into position, 1 by 3-in. wood (pine) strips and a flood coating were used for protection of the coating.

Prior to commencement of construction operations there was considerable discussion as to whether or not, and as to what means, welds should be inspected to insure against leaks. Fundamentally, it is the author's opinion that the quality of any weld depends on the ability of the individual welder. Consequently, the basic safeguard in this matter is the careful selection of competent welders and strict supervision over their work.

It was finally decided that in addition to establishing a rigid standard of performance for welders, the line would be tested with 100-psi. air pressure and that the joints would be soaped for visibile inspection. A collateral benefit resulting from this decision was the fact that it made it possible to run a pig through each section of the line, cleaning it of foreign material.

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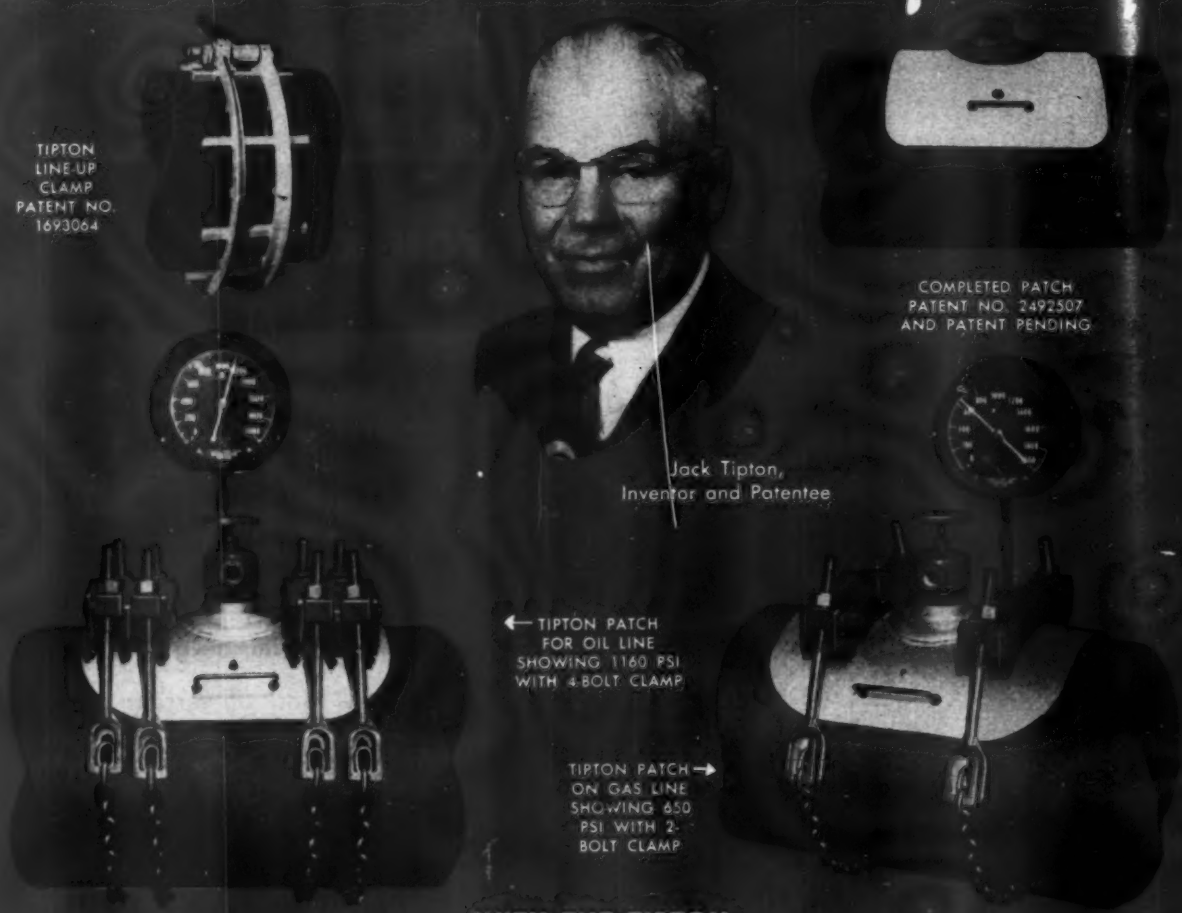
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The steel patch clamps hold the patch firmly in place during installation. The special rubber gasket is so designed that the high pressure against the gasket, when compressed with the vent plug closed, helps to seal off the pressure. The pressure never gets beyond the center of the 6" gasket which is enclosed with a steel casting ring.

After stringer bead is put on, clamps are removed and electric welding is completed.

In designing the Tipton Patch and Clamps, Mr. Tipton, with his 40 years' pipe line experience, has kept in mind not only the making of the safest patch, but also the safety of the electric welder while installing the patch.

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the Van Dyke end protectors and all other precautionary measures, any pipe liner appreciates how foreign matter can accumulate in a line and how troublesome it can be. Therefore, as soon as the pig was run through a test section, usually about 6,000 to 7,000 ft. in length, a bull plug was attached to the far end and the line pressurized immediately. By this procedure five pinhole leaks were detected during the course of the entire operation. Considering the number of individual welds in the line as a whole, this record is believed to be remarkable.

In addition to the five pin holes, had the air pressure not been applied we would have had at least one serious leak caused by a slag inclusion in the interior of the pipe, not apparent from a superficial outside examination.

Following the air test, the line was doped. Initially, company representatives were of the opinion that it would be possible to cradle the line directly into the ditch behind the doping machine. Now, based on additional experience, it is recommended that the freshly doped line be left on skids for at least a few hours before cradling into the ditch and backfilling.

Upon completion of the line company representatives were sufficiently confident of the results achieved to recommend that the line be put into actual operation without a hydraulic or air test of the completed line or of any of the major portions between division valves. During filling, one leak was discovered in the vicinity of Rock Springs. This was apparently caused by careless handling of a backhoe during removal and lowering of the line where a sheep crossing had been installed. Not a single defective weld has been disclosed to date.

In mid-December of 1948 contract was let to Evans & James Construction Co., Little Rock, for laying 383.66 miles of line between Refugio and Crane. Subsequently, the contractor was awarded a second contract to extend the line 28.63 miles from Refugio to Port Aransas, making a total of 412.29 miles of line constructed as part of this project.

From the standpoint of construction difficulties the worst section of line was in the dissected plateau country extending generally from a point opposite Ozona to a point just north of Highway 90, west of San Antonio. Roughly speaking, this constituted the middle third of the line. This section, as previously indicated, was over rough terrain which required a continuous rock ditch. As shown by Fig. 1, Sonora was the only rail head immediately accessible to the line between Barnhart on the Santa Fe System west out of San Angelo, and Sabinal on the Southern Pacific System west out of San Antonio. The main highway system, though not as extensive as that on the upper and lower sections of the line, was adequate but there was a scarcity of secondary roads. In fact, between Highway 29, east of Rock Springs, to a point below Sonora, a distance of over 40 miles, not a single public road and very few private ranch roads cross the line.

As if the obstacles of terrain and communication were not enough, this area was that most heavily infested with bitterweed, causing a considerable loss of time and effort in decontaminating the equipment. Further, this area was generally denied for construction activities until after approximately May 15, due to the ranchers' objections to have construction in progress during lambing season. Also, the deer season normally opened November 15 and it was desired to have all operations completed before that date to avoid complications with regard to these leases and to avoid ill will with the landowners.

The southerly portion of the line in the coastal plain area presented no unusual difficulty and was through an area well served by both railroads and highways.

The northerly or upper portion of the line was in favorable terrain, adequately served by highways and

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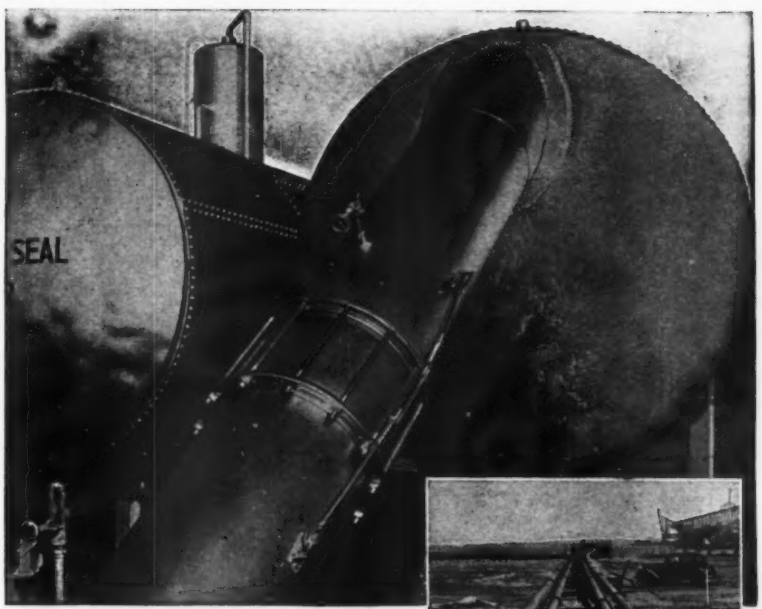

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railroads, but here the contractor soon found that considerable effort was necessary to provide a ditch through those areas having a shallow or no soil mantle.

The first shipment of approximately 100 miles of pipe left the mill by rail on December 17, 1948, and shipments of approximately the same size were made monthly thereafter until the order was completed. Generally speaking, the mill required approximately 10 days to load out a shipment. In view of the quantity of pipe involved, and its distribution at selected rail heads, it was found necessary to unload cars at as many as five points simultaneously. Consequently, considerable burden was imposed on the contractor and on Atlantic to receive and unload the cars to avoid or at least minimize demurrage. The possibility of stringing directly from the cars was out of the question, and it was unfortunate that the company was unable to exercise greater control over these deliveries. As a further result, arrangements had to be made for considerable pipe-storage space not previously contemplated.

The pipe required for the construction of the Refugio-Harbor Island section of the line was delivered by barge into Corpus Christi and stored in a local pipe yard until required by the contractor.

The contractor started construction operations on January 4, 1949, with a spread working from Refugio to the north. This spread continued working northward until August 1, at which time approximately 200 miles of line had been laid. The organization of the contractor's crews and the method of operations over this section warrants no special comment except to state that progress was not up to our expectation. The one bright spot in the picture, however, was the fact that the contractor had organized a rock gang which Atlantic's representatives were confident would be able to handle the job ahead.

During the months of May, June, and, July even though the contractor was now well organized for rock operations, only 60 miles of line was completed. It was obvious to the author that the contractor was losing considerable money and that the company was losing valuable time by the contractor having the entire operation dependent upon progress of the ditch gang. Even though at the end of July more favorable terrain was being encountered, and it was normal to expect some acceleration, many miles of rock ditch still remained. At this point the author felt compelled to suggest to the contractor that he cease all construction from the south, except for that required to get right-of-way and rock ditch, and for him to start a second full spread at Crane and work southward.

It was the author's thought that when ditching operations had proceeded 40 to 50 miles ahead of the pipe, full operations could then be resumed at a savings in money to the contractor and in time for the company. Atlantic's representatives were somewhat apprehensive about the ranchers' reaction to the existence of open ditch through their properties for a period of a month or more, but in view of the stakes involved for the company, it was elected to gamble, counting heavily upon the excellent landowner relationship which the company had enjoyed. By providing sheep and cattle crossings where required, no protests were received, and the ranchers were well satisfied.

Contractor's organization.—As soon as the contractor entered the rock country north of Highway 90, he realized that the future success of the job depended upon his organizing an efficient rock gang. This he proceeded to do, exercising considerable ingenuity not only in the selection of the various types of equipment required to do this job but also in organizing the required personnel. Further, it is to the contractor's credit that he never stinted the job for lack of adequate tools or personnel. To Atlantic representatives' minds this rock gang was one of the finest equipped, the best organized, and most productive crews seen in their experience. It is also to the contractor's credit that at this time he furnished the spread with the best men available, equipped with sufficient and adequate tools to get the job completed.

It was soon found, however, that to shoot and dig a narrow trench in rock presented entirely different problems from those encountered in mass excavation. Therefore, when the contractor entered the rough plateau country he entered into a trial-and-error period trying to evolve a satisfactory technique and sequence for the trenching. The most troublesome type of rock encountered consisted of the heavily stratified and fissured layers lying at the surface of the ground.

No amount of experimentation with hole space, depth, or charge would shatter the rock and eliminate the upheaval of a mass of boulders as shown in Fig. 9. After a period of such experimentations and consultations with explosives experts from the major powder companies, the contractor elected to drill a series of blast holes in a straight line at 3-ft. intervals along the center line of the ditch. These holes were drilled to a depth of 6 ft. and were loaded with 1½ lb. of 40 per cent dynamite. The drilling was done entirely with wagon drills and drifters mounted on the equipment described below.

Wagon drills.—The first, and probably one of the most useful tools put on the job by the contractor, consisted of a 500-cu. ft. per minute air compressor mounted on a converted

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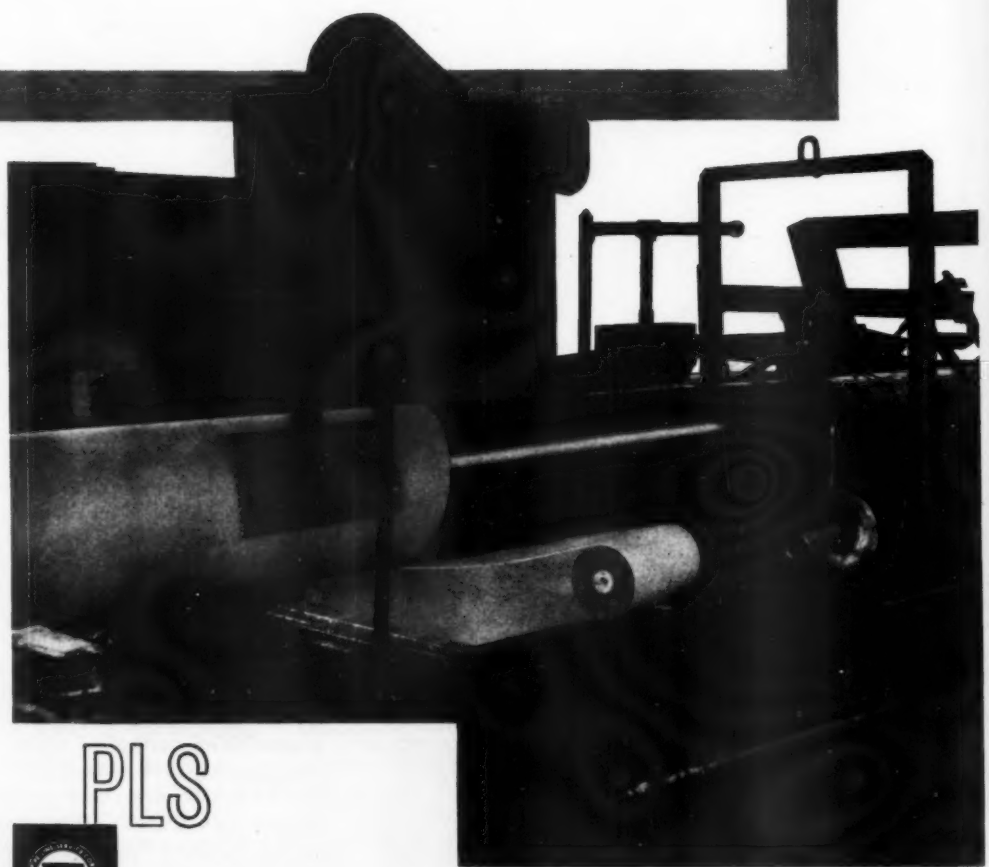

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army half-track. The chassis of this vehicle was extended, permitting a side-bar arrangement to be rigged on the outboard side. Six wagon drills were then mounted on the side frame, correctly spaced for the drill holes. When in position two drills worked simultaneously until all six holes had been completed. An additional advantage of this machine was its ability to move alongside a partially excavated ditch and do any supplementary drilling required for shooting out humps or for lowering the ditch. The contractor felt that for future operations a unit of this sort could be utilized in a large measure, dispensing with the use of hand-jackhammer crews used on cleanup operations. For illustrations see Fig. 10.

Single drifter.—A second type of drilling rig used by the contractor and the one which was probably the most versatile, consisted of a 300-cu. ft. per minute tractor-mounted compressor, with the compressor being driven by the tractor engine through a power takeoff. On this rig the drifter was mounted directly on the front end of the tractor. This unit was extremely useful where the going was rough and could be used in many locations, and many times, where the half-track and the towed rigs required assistance to negotiate the slopes. This machine also had the highest unit production per drifter of any of the units used. For illustration see Fig. 11.

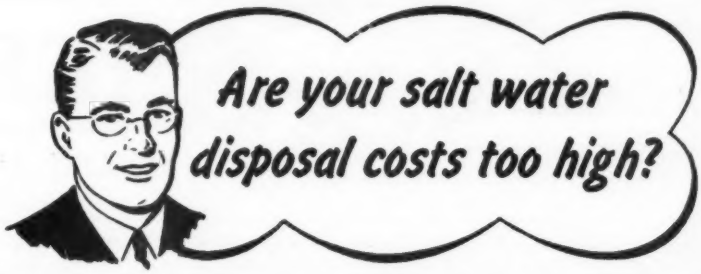
Double drifters.—The third, and the more generally used piece of equipment, consisted of double drifters mounted on a single rig. Air was supplied from a 500-cu. ft. per minute air compressor. The drifters and rig were hooked in tandem and towed by a suitable tractor. See Fig. 12.

In over-all production the contractor was able to achieve approximately 600 lineal feet of rock ditch per day from each of the drifters. This rate, however, was dependent on his working in terrain where the equipment could move under its own power and did not require anchoring or assistance on steep slopes.

Jack hammers.—The normal operations of the rock gang, in sequence, was the drilling and blasting. After blasting, a D-8 tractor was used to level the rock to permit the backhoes a better opportunity to work on the rough ditch. Following the battery of backhoes, normally three or four, making the rough ditch (see Fig. 13) came a jack-hammer crew drilling any necessary additional holes by hand where required to blast out the humps or to get additional depth. Ordinarily, a second shooting would suffice, permitting one backhoe to be used as a cleanup machine, producing finished ditch. In many cases, however, a third blasting was necessary before the ditch would be accepted.

At the time the decision was made to suspend all operations on the original spread, the rock gang was so well organized and equipped that it was able to average slightly under a mile of rock ditch per day. For general information, the organization of this gang was preserved intact throughout the entire operation.

Rooters.—When the contractor started the second spread southward from Crane, he did so with the expectation that the ditching operations for a considerable distance could be handled by the small Cleveland ditchers used so successfully on the southern portion of the line. However, this was not the case as he ran into immediate trouble because of the heavy caliche and rock underlying the shallow soil mantle. As a result, the contractor found himself compelled to add rooting and drilling equipment, obtain heavier ditchers, and move in backhoes in order to keep ahead of the pipe gang which should have and did lay up 12,000 ft. of pipe per day in this country, provided sufficient ditch was kept ahead. Although the contractor did finally build up the ditching gang to a point where he was able to stay ahead of the pipe gang, the buildup was so slow, and production during the month of August so disappointing, that in September the author felt it necessary to make



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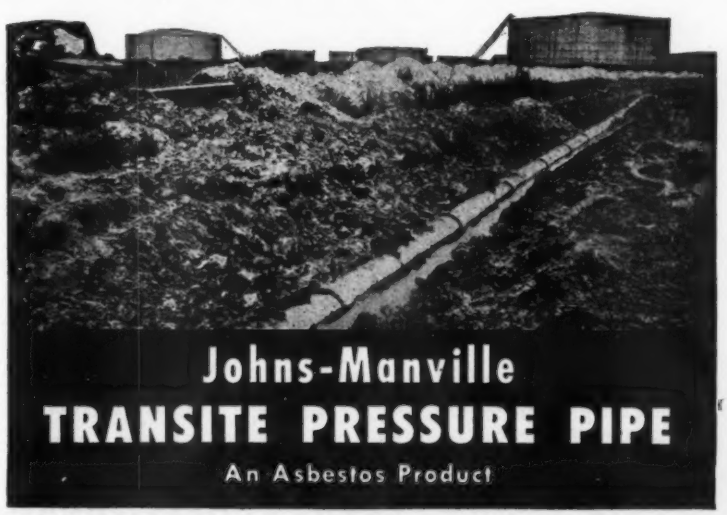

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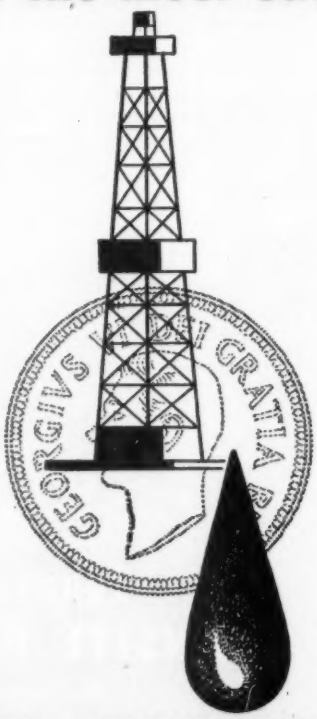

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a personal inspection of the line and to take whatever steps were necessary to insure completion of the line if possible around the first of November.

As a result of this inspection, steps were initiated to resume full operations in the south and to do everything possible to push the gang from the north. Around the first of October it became apparent that the pipe gang working from Crane was going to overtake the ditch at a point on the line opposite Ozona unless a full rock-ditch gang was organized similar to that working from the south. Events by this time had taken a better turn and it was felt that enough ditch had already been opened from the south to permit shifting the original rock gang ahead of the Crane spread. At this time the rock gang was reinforced with the better rock equipment then available from the Crane spread. With this additional equipment the contractor was able to produce approximately 6,500 ft. of rock ditch per day, even under difficult conditions. This was considered the maximum for efficient operations.

Final summary showed that approximately 160 miles of rock ditch was produced by blasting, with an additional amount of approximately 70 miles being produced with backhoes, with the use of rooters ahead of the larger ditching machines, or all in combination.

By the results of extraordinary efforts about 120 miles of line were laid during the last 60 days of construction in spite of the fact that a full week of production was lost on account of rain.

The line was completed November 22, 1949. Filling operations started almost immediately with oil being delivered to Harbor Island on December 7, 1949.

Construction of the Refugio-Harbor Island section of the line was completed in early November, well ahead of the main section. Because of the existence of several extensive marshes, a crossing of Copano Bay, three river crossings, plus a section of line through the town of Port Aransas, the contractor elected to finish these sections first by using small crews, upon completion of which a full spread was engaged to finish the line.

The importance to the ranchers and their attitude toward the question of bitterweed made it incumbent upon us to pay considerable attention to the decontamination of our equipment to minimize its spread by reason of our pipe-line operations. The severe stock losses which are caused by this plant has forced many ranchers to expend considerable sums of money to eradicate it from their lands. Consequently, any rancher who had gone to the trouble and expense of cleaning up his land does not look with favor upon any activity that is likely to reinfest it. The first step in handling this problem was for Atlantic's land department representatives to conduct a detailed survey through the bitterweed country to determine the existing degree of infestation and to ascertain whether or not, in the rancher's opinion, a property was considered free or infested and whether or not decontaminating was to be specified in the right-of-way agreement. For conducting this survey a local resident who was held in high repute throughout the community was engaged. In general, the right-of-way agreements throughout this area specifically stipulated that the equipment would be decontaminated before it left an infested area and before it entered upon a free tract. However, subsequent events demonstrated the fact that the individual landowner became the sole judge of which tracts were infested or which were free, and in many cases decontaminations were insisted upon above and beyond those specified in the right-of-way agreements.

The approved method for conducting decontaminating operations consisted of constructing a platform, thrown together from loose planks, at the decontaminating point. The equipment was cleaned by hand as well as possible and then placed on the platform and thoroughly steam cleaned before it was allowed to proceed. The most successful rig found for this operation was owned by a contractor in the Odessa area who specialized in the cleaning of crude tanks. His equipment consisted of a truck-mounted flash boiler of a type used on diesel passenger trains. He possessed a fleet of these units and consequently was able to provide service where and when required.

Decontaminations came so frequently in the Ozona-Sonora section that it was not uncommon to find the right-of-way gang being decontaminated at one point, the stringing gang at another, the ditch gang at a third, and possibly the pipe gang at a fourth. Even though the requirements seemed far fetched in many instances, company representatives insisted that operations be thorough, with the result that in the spring of 1950 nothing extraordinary was disclosed to indicate that Atlantic's operations had furthered the spread of the weed.

Shortly after company activities got under way, representatives became aware of infringement of operations upon the rights and property of the individual landowner. It was felt the best way to allay the fears and suspicions of the landowners was to keep them informed of the general nature and timing of operations.

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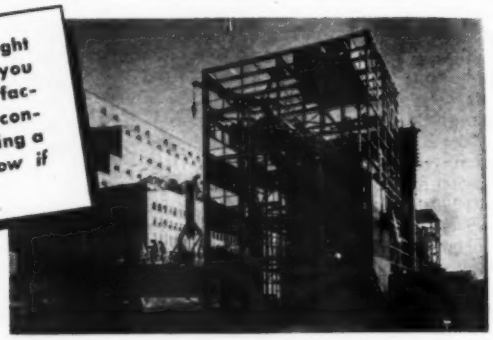

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Accordingly, one inspector was assigned to each spread to maintain constant liaison with them. This contact started prior to the cutting of the fences and continued until the fences were closed. The landowner was advised that this inspector would receive any complaint which he might wish to make. Further, this same inspector would contact with the landowner at the time of cleanup to ascertain whether or not he was satisfied. Many ranchers expressed their gratification of this procedure, stating that it was the first operation of the sort where they had not gotten the "run around." This policy, together with the contractor's attitude and wholehearted effort to comply with right-of-way agreements, contributed in no small measure to the successful completion of the line. The contractor, on his part, graded countless miles of private ranch roads in return for certain privileges, and sometimes for just plain good will. The results, however, were to the mutual advantage of all.

The construction inspector who was responsible for liaison with the landowners was in no wise empowered to make settlements of claims of damages. This matter was the responsibility of the land department, but the intimate knowledge which this inspector had acquired during construction ofttimes made his presence invaluable at the time of a settlement. To effect the quickest possible settlement, a representative of the land department was retained at construction headquarters during the entire period of construction. It is believed that the success with which this system worked can be attributed to the fact that upon completion of the line less than a dozen outstanding claims remained for disposition and of these only one was of major importance. All claims were settled without undue delay.

As previously stated, the contractor's organization for the conduct of operations was along conventional lines except for the rock gang which has been previously described. Atlantic's organization was comparatively straightforward and simple. Acquisition of right-of-way and the settlement of damages and claims were handled by its land department, under J. H. Wood, Jr., vice president and general manager of Atlantic Pipe Line Co., Dallas. All other phases of operation, including engineering, design, specifications, requisitioning of material, contracting, and inspection were handled by Atlantic's engineering and construction department under the supervision of the author. The field organization, reporting directly to the construction manager, C. E. Mullins, consisted of a construction engineer in charge, one office clerk, and one or more material men as required.

Each spread was supervised by a group of four inspectors headed by a spread inspector.

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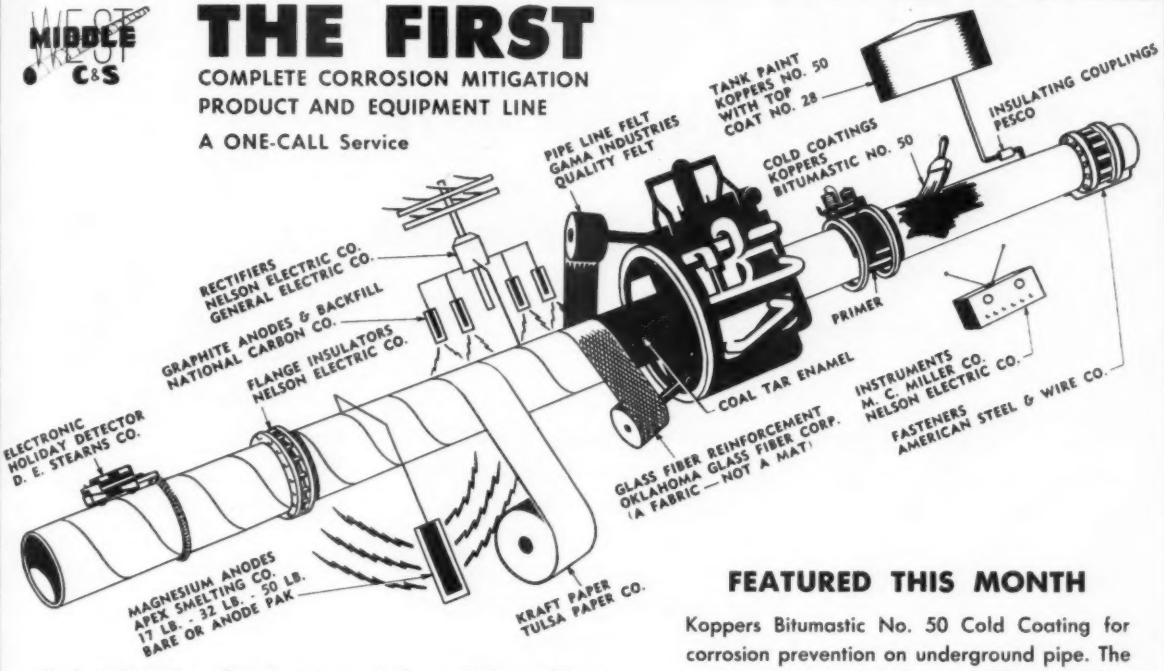

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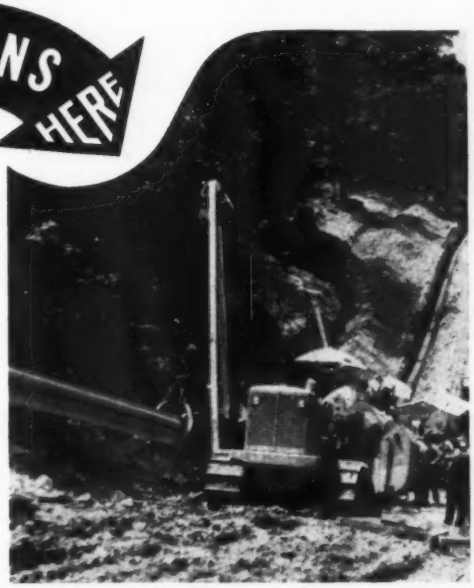

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SURVEYING PIPE LINES FOR RECONDITIONING DATA

. . . Using Surface Potentials

by James R. Cowles*

Conclusions

Surface-potential surveys afford a reliable method of determining serious corrosion on bare and poorly coated pipe lines. While skill is required to interpret results in certain instances, the data are surprisingly definite even to field men observing the work. Cost of equipment is moderate, being a few hundred dollars. Survey costs and the man hours required for the work are appreciable.

THE location of corroding sections of pipe lines is again receiving attention by corrosion engineers as the possibilities of the technique known as "surface-potential measurements" is explored. To evaluate this procedure with respect to its own operation, Oklahoma Natural Gas Co. has surveyed sections of three different lines using various checks on results.

Case Histories of O.N.G. Jobs

Tests on a welded line.—The first survey covered 3,025 ft. of 8⅝-in. o.d. 16.89-lb. per foot solid welded bare line in a sandy soil underlain with rock. After completing the survey, 20 excavations were made at the points where the most corrosion was indicated.

Four leaks were found in this survey. The condition of the pipe, based on average per cent of wall thickness penetrated as found by averaging the depth of the four deepest pits† found, was 55.3 per cent.

Tests on Dresser coupled lines.—Surface potentials are electrical voltages caused by galvanic action. Ordinary Dresser couplings are known to vary from conductors to insulators and it seemed that the random electrical insulation afforded by the couplings in Dresser-coupled line might preclude the use of the technique on such lines. To prove or disprove this, a pair of parallel coupled lines (far enough apart so as to be independent for test purposes) were checked. These lines were 12¾-in. o.d. and 16-in. o.d. sizes. Authorization to spot recondition 3,575 ft. of the 12¾-in. o.d. pipe and 2,475 ft. of 16-in. o.d. pipe was available making it reasonable also to compare costs of replacement based on such surveys with costs of replacement under normal procedures. These lines had very poor coatings in some places.

A total of 6,450 ft. of pipe was surveyed. While the data did not present as pronounced indications as had been found on the welded line, nothing was found to indicate that the method did not apply as well. As it was decided to substitute cathodic protection for most of the reconditioning, very little pipe was examined. The most satisfactory confirmation of the tests on these lines was the occurrence of seven leaks, after the survey was run, at points where service corrosion was indicated.

There were also numerous old excavations discernible along the line surveyed. It could not be assumed, however, that they were all due to corrosion leaks, so only known corrosion leaks were recorded. Four were noted as indicated spots and only one was noted which was not indicated by the survey or was not within reasonable distance of a known leak repair where an anode had been installed (anodes or cathodic protection change these potentials).

Savings made.—The saving, which would have resulted had the reconditioning program been carried out, but modified in accordance with the survey findings, is estimated as $13,650 or 58.3 per cent of the original estimated cost. The percentage of corroded pipe was about 20 per cent but much of this represented very short sections close together. Actually, the lines are being cathodically protected with a minor amount of reconditioning at an estimated savings of $10,240.

Completeness of survey indications.—The last phase of checking involved the surveying of sections of another 16-in. o.d. line which were to be reconditioned. The purpose of this survey was to ascertain if any serious corrosion not predicted would be found. Again an almost negligible coating existed. Reconditioning of the line began before the survey was started, hence the survey was not in great detail. Potentials were measured at intervals which indicated that a good or bad joint of pipe was being spanned. Six sections covering 1,600 ft. were examined. The surveys indicated 43.4 per cent of the pipe to be corroded. Examination of the excavated pipe showed 75 per cent of the footage to be less than 80 per cent in condition, again based on the percentage of the pipe wall penetrated as indicated by averaging the depth of the four deepest pits found. The only serious corrosion not predicted was one location where the corrosion was not of the pitting type.

Theory

Without going deeply into the theory, consider that underground corrosion is always accompanied by the flow of electricity from the metal corroded, using the conventional belief that electricity flows from positive to negative in metallic conductors. It is common knowledge that the corrosion which causes leaks is usually spotted and it then follows that unusually large quantities of electrical current flowing in a specific direction should be found in the soil around pits. These currents produce measureable effects on the surface of the ground above the pipe line just as the flow of water from the end of a water hose submerged in a shallow pool of water produces a disturbance at the surface of the water in the pool.

Technique

Surface potentials are not new, and their application as outlined here is literally a technique. The measurements actually made are potential differences (pressure differences) in terms of millivolts (thousandths of a volt) between conventional copper

*Engineer, Oklahoma Natural Gas Co., Tulsa.

†When a leak was found the pipe was rated zero per cent condition even if only one pit existed.

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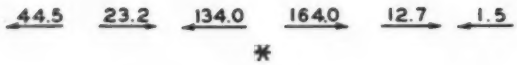

Fig. 1

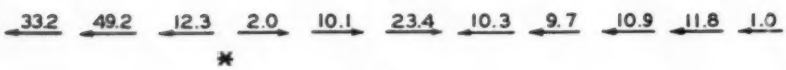

Fig. 2

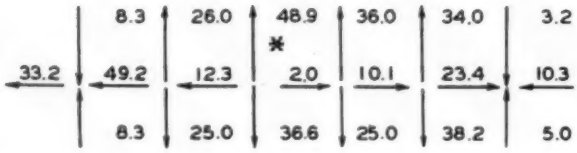

Fig. 3

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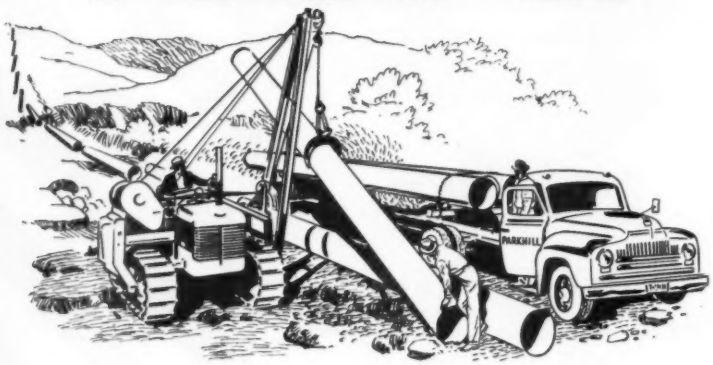

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sulfate electrodes placed on the surface of the ground. It is important that these electrodes contact with undisturbed soil below grass root depth if reproducible readings are to be obtained.* The locations of the electrodes vary except that one is always directly above the pipe. (The method is so sensitive to electrode position that a pipe locator must be used to ascertain that an electrode is placed accurately over the pipe when this location is desired.) The first rough survey is made by placing electrodes above the pipe every 25 ft., "leap frogging" the electrodes, i.e., when moving them down the line using the same electrode for the reading on each side of a given point. The results thus obtained will be something like those illustrated in Fig. 1. Arrows show direction of current flow in each 25-ft. interval and the numbers are millivolt readings. Obviously considerable current is flowing from a point near that indicated by an asterisk.

Fig. 2 illustrates a survey of 44 of 50 ft. covered by the 134.0 and 164.0-millivolt arrows when the electrode spacing is reduced to 4 ft. The 44 ft. were those of the 50 in which readings were found of the type sought. There is now only one clear-cut point where current is leaving the pipe. This is marked with an asterisk. By noting the variations in readings, particularly to the right and left of the asterisk, however, it appears that current may be leaving the pipe over a 20-ft. length or about one joint of pipe. The survey could be discontinued here, a joint replaced and the pipe between the arrows at the extreme right examined. The picture is not completely satisfactory, however, from a survey standpoint. If one electrode is placed over the pipe and one 4 ft. to one side of the pipe current flows at right angles to the pipe can be explored. Fig. 3 is an extract of Fig. 2 with these side readings added.

These figures clearly show a divergence of current over the 20 ft. of pipe with a clear-cut convergence on the right (a noncorroding spot) and figures indicating definite convergence on the left. No further measurements are indicated. However, the electrical limitations imposed by instruments and difficulty in placing electrodes on a predetermined pattern have not been reached. In fact, the movement of an electrode 6 in. will have pronounced effects in areas such as illustrated.

To complete the data on the illustration it should be pointed out that the pipe was excavated at the asterisk point in Figs. 2 and 3. This is 12 ft. to one side of the asterisk point in Fig. 1. A leak was found on the top of the pipe and pits on the pipe averaged 0.080 in. There was also a

*Difficulties may also be expected in roads, on hard-packed surfaces, and on concrete.

heavy scale on portions of the pipe.

It is interesting to regress and consider the correlation of currents flowing parallel and perpendicular to the pipe. The flow of current in the soil follows the classical pattern as formed by iron filings on a piece of paper above a magnet.

The observations made are components which have to be combined to get actual flow. But the fact is that irregularities in the soil and other physical conditions will distort the flow of current so that a classical pattern seldom results. Often this is obvious from a set of measurements where all current flows away from one side of the pipe only.

With the foregoing factors in mind 10 sets of measurements were plotted to learn if either parallel or perpendicular measurements, or even pipe to soil measurements would differ much in providing data for interpretation. All correlated, remarkably well. Perpendicular measurements seemed to offer slightly larger numbers to deal with, however. In a few cases the desirability of both was indicated. From a practical standpoint parallel measurements, i.e., measurements along the line, are indicated. Perpendicular measurement are then useful to clarify unusual observations.

On the basis that the sum of the parts equal the whole, a pipe-to-soil potential at one point can be carried forward to another point by adding and subtracting surface potentials. This is useful as a check on data obtained. Some operators also make use of this fact to obtain data over a length of pipe by moving only one electrode. One precaution is noteworthy. If contact with the pipe is by an uninsulated prod bar it should be quite a few feet from the copper sulfate electrode as it will create a distrubance in surface potentials near it. In a similar way, side gates and such will distort surface potentials.

The illustration given above was, of course, chosen because it was clear cut. Comparing data from all spots on all lines checked showed that while the readings are definite in the general case a few confusing situations arise. First each line or area along a line seems to follow its own pattern, which becomes clear as the survey progresses. On the welded line, where the foregoing readings occurred, it was found that with 25-ft. electrode spacings, readings of less than 100 millivolts could be disregarded. On the parallel lines, however, the direction of current flow, as indicated by the number of diverging arrows in the illustration, seemed to be more related to past leakage than did the magnitude of the meter readings. In the case of the last 16-in. o.d. line, where only over the pipe electrode readings on 25-ft. spacings were available, most converging potentials ran from 25 to 80 millivolts but direction was at least as important as amount of potential.

The first obvious factor affecting current flow as indicated by surface potentials is the force required to drive a unit of current through the soil. This factor is soil resistivity which was measured with Shepard Canes and is usually recorded in centimeter-ohms (or ohm-centimeters which are sometimes called ohms per centimeter cubed—all metric units except as affected by the factor of "ohms"). This varies rapidly and should be recorded along stretches of pipe where corrosion is indicated. Aside from affecting the meter readings per unit of current flowing in the soil such measurements are valuable for interpretation of the corrosiveness of the soil along the pipe. Often they explain why corrosion is found in specific areas and thus assist in understanding what corrective measures should and can be taken.

The second factor affecting current flow as indicated by surface potentials is the line depth. Less effect will be felt from current flowing deep in the ground than when the same quantity flows near the surface. Pipe size would be a third factor if current flowed evenly from around the circumference of the pipe. This is not generally true and is probably best neglected. Combining the factors of soil resistivity and pipe depth and assuming uniform radial flow of cur-

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rent from the pipe, the following factor results:

$$\frac{1}{\rho \log \left(\frac{h^2 + x^2}{h^2}\right)}$$

Where:

ρ = soil resistivity in centimeter-ohms
log = logarithm to base 10
h = depth of center of pipe
x = electrode spacing, units consistent with h, (in., or ft.)

For many reasons this factor is not likely to be highly accurate, but it does afford a means of reducing readings at various locations to a common base. For example, it shows that a 30-millivolt reading in 333.3 centimeter-ohm soil is indicative of as much corrosion as is a 180-millivolt reading observed under the same conditions in 2,000 centimeter-ohm soil or that a change in pipe depth from 4 ft. to 1 ft. will have the same effect.

Surface potentials are one of the most difficult measurements of voltages to obtain. Voltmeters are rated in ohms per volt and high resistance is necessary. A meter with a full scale reading of 50 to 100 millivolts on up to about 800 millivolts is needed. Even a high-resistance voltmeter, say 200,000 ohms per volt, has only 20,000 ohms resistance on a 100-millivolt scale, which is not considered a very high resistance. Such meters are successfully used, however. They are somewhat slow in response. Potentiometers would seem the better choice, but they must be rapid in operation.

A potentiometer - voltmeter can, perhaps afford the best performance. Quick response by the instrument used is important as several hundred readings a day will be made in normal work. Copper sulfate electrodes should be of a type which permits easy cleaning of their copper surface.

Shepard Canes or equal soil resistivity equipment are suitable until pipe depth exceeds prod bar limits. A four-point device or hookup of batteries to go with the surface potential equipment is then necessary. The pipe locator should be of the midget radio-frequency type.

A crew of three men is the minimum, and a fourth man is valuable. Two men carry electrodes and a unit of the pipe locator. The third man reads the instrument and records. To visualize a crew in operation consider the taking of 25-ft. readings starting with both electrodes in place and the meter located at the forward electrode. As soon as the reading is obtained the back man moves forward past the front electrode man and instrument man. He leaves the pipe-locator transmitter, picks up the locator receiver and a shovel. Using the long electrode wire as a measure he marks a line on the ground above the pipe with his foot. Exact location of the electrode along this line is then determined with the pipe locator. Sod is removed at this point and the electrode placed. After the reading is obtained, the electrode man and recorder move forward past the electrode man who was ahead.

Soil resistivity can be measured at points of interest by any of the members of the crew as such points usually occur close enough together that backtracking for equipment is not a serious problem. A somewhat more complete procedure is to make a separate survey of soil resistivity with the pipe locator ahead of the surface potential survey so that a knowledge of the approximate soil resistivity in each section is known in advance of the surface potential survey.

The simplest possible survey will cost better than $100 per mile. Slightly over $500 per mile was spent to secure some of the detailed data used herein.

Acknowledgment

The author is indebted to Minick and Veneigh for the field data used, to H. M. Hughes for field supervision and correlations upon which this paper is based, and to William Huddleston for valuable suggestions.

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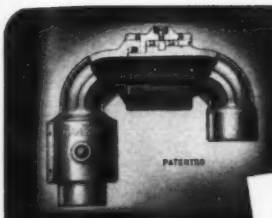

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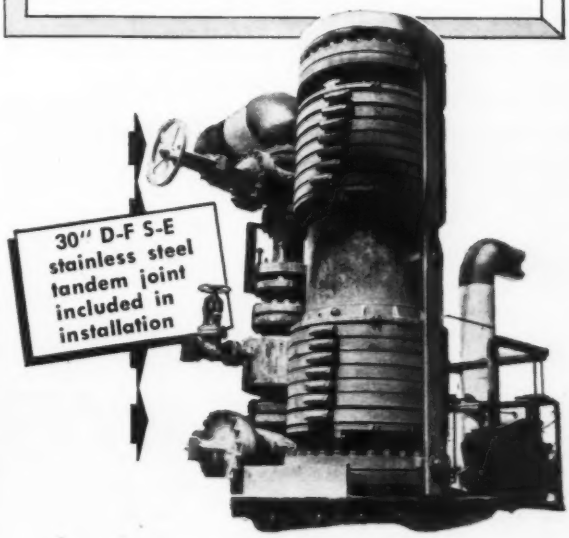

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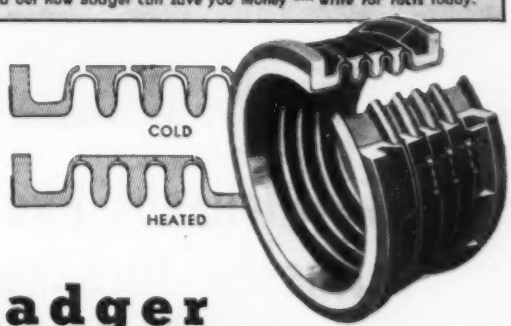

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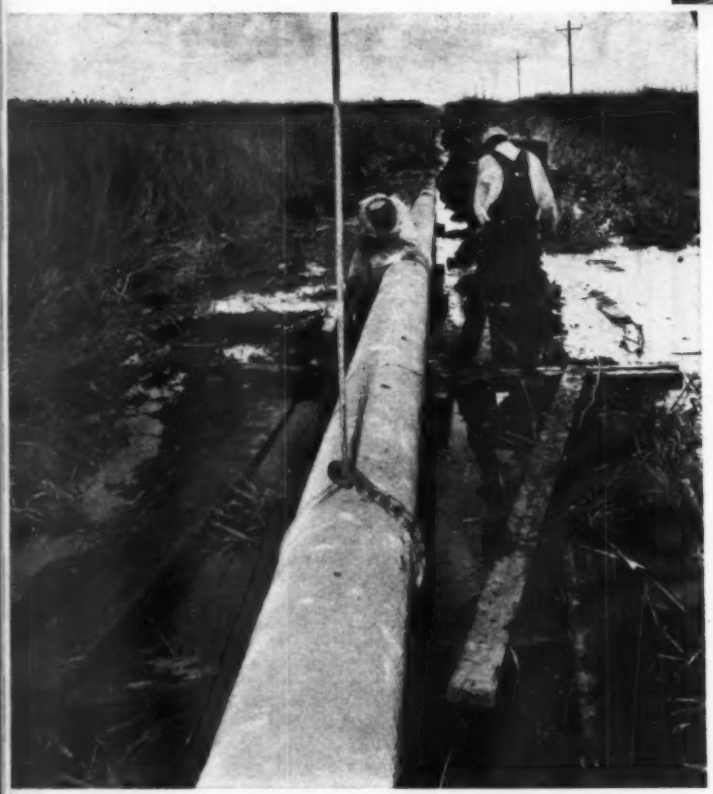
"Wate-Kote" on section of Tennessee Gas Transmission Co. 12" line near Holmwood, Louisiana



"Wate-Kote" applied to Tennessee Gas Transmission Co. 26" line near Greenville, Mississippi.

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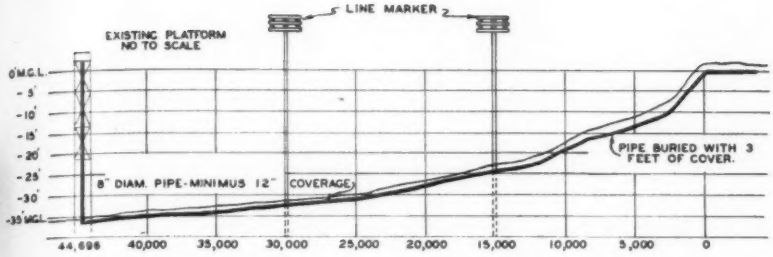
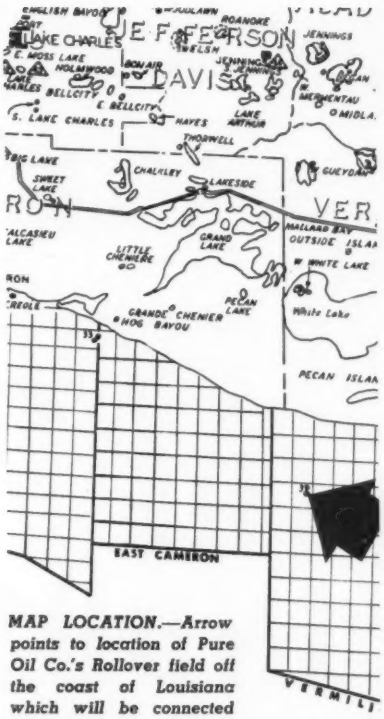


PROFILE.—This drawing shows the underwater profile of Marine Gathering Co.'s Gulf of Mexico gas line. The line runs 8.44 miles from shore and is 35 ft. below "mean gulf level" at Pure's platform.

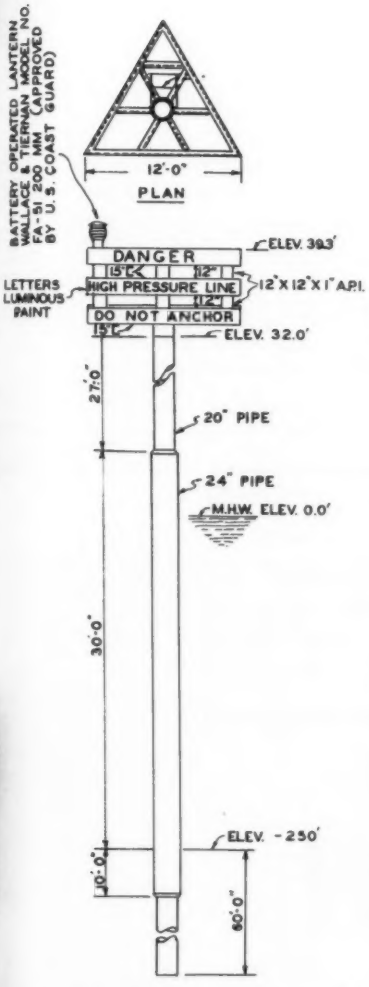


MAP LOCATION.—Arrow points to location of Pure Oil Co.'s Rollover field off the coast of Louisiana which will be connected to the shore with new submarine gas pipe line.

Offshore Line

Ocean-going gas pipe line presented a variety of unusual problems to builders, both in planning stages and during actual construction

by Leigh S. McCaslin, Jr.
Houston District Editor



ANTIANCHOR MARKER.—Two of these large protective markers are being installed along the route of Marine Gathering's high-pressure gas line.

CONSTRUCTION is under way on the first offshore gas pipe line in the tidelands waters of the Gulf of Mexico—a line which has been dubbed "the world's first ocean-going gas pipe line."

The techniques being used in this pioneering endeavor are being closely watched by all with interests in the gulf. Special equipment and new methods are involved in much of the operation. The line is being laid by Submarine Pipe Line Co. for Marine Gathering Co. Sammy Collins, vice president of Submarine, is in direct charge of the laying operation. Robert C. Ledford, operations manager for Marine Gathering, is responsible for much of the original design and planning and is following the operation closely.

The 8⅝-in. line will tie into gas reserves developed by Pure Oil Co. and can deliver 50,000,000 cu. ft. daily to the land system of Tennessee Gas Transmission Co. It extends from the coastline of Vermilion Parish, Louisiana, 9 miles into the gulf to Pure's drilling platform above Rollover field, which is in 36 ft. of water.

Several major problems presented themselves during the initial planning stages of the offshore line. How was the pipe to be protected from corrosion? What method was to be used to bury the pipe? How could barnacles be prevented from attaching themselves to the pipe and damaging the protective coating? How could this high-pressure gas line be protected from the danger of boat anchors which might catch the line and rupture it? What laying method would be best suited to the strong currents and sudden squalls of the Gulf of Mexico?

PIPE-LINE Section

To solve these problems, Ledford contacted a large number of Gulf Coast concerns which have had experience with underwater pipe lines. Aluminum Co. of America proved to be a major source of information and advice. A few years ago Alcoa laid several miles of line in Matagorda Bay on the Texas Gulf Coast. Since initial installation, Alcoa has pulled part of this line to the surface and examined it to determine the effectiveness of their laying and wrapping methods. Much valuable knowledge, which could be put to good use by

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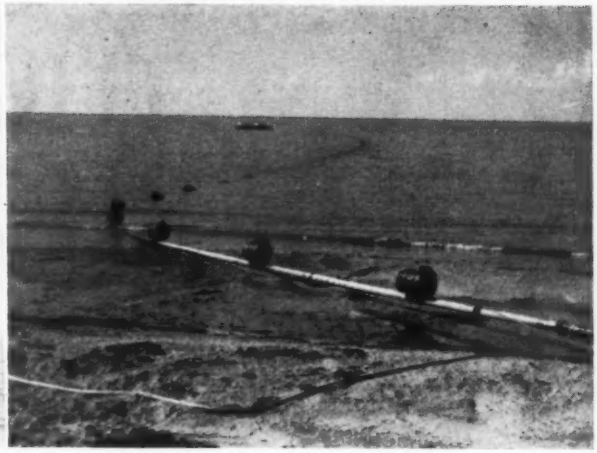


PLATFORM FOR DRILLING-PRODUCING.—(Left) From this "at sea" location of Pure Oil Co., gas of 2,600-2,800 psi. pressure will feed into the submarine pipe line. OFF TO SEA.—(Right) This 4,000-ft. section of 8⅝-in. pipe goes to sea via "Mae Wests" (55-gal. oil drums).

Marine Gathering, was gained from this examination.

A primary problem, of course, in the laying of an underwater line is that of coating. The coating procedure finally decided upon by Marine Gathering is as follows: First step, after mechanical cleaning of the pipe, is to apply a coat of pipe-line primer. Secondly, a 3/32-in. coat of Pittsburgh Coke & Chemical Co. plasticized enamel is applied. This enamel was selected because it does not get brittle in cold water. During laying operations in water it has been found that the pipe is subject to considerable flexing. If a brittle enamel were used it would be flaked off during the laying operation.

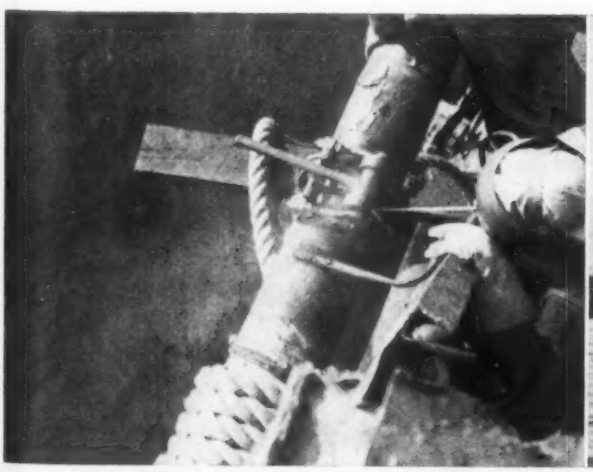
Third step in the coating operation is the application of Owens-Coring Fiberglas Coromat. Next, a 1/16-in. coat of enamel is applied and followed by a wrap of Owens-Corning glass felt. The sixth step consists of a final coat of plasticized enamel 1/16 in. thick. Finally, the pipe is wrapped with 70-lb. kraft paper to protect it during laying.

It will be noted that two wraps consisted of glass materials. This was done purposely because of the good dielectric qualities of glass. For the few joints which have to be welded together over water as the line is being laid, a slight change is made in the wrapping procedure. Owens-Corning Glassfab is used in the place of the Coromat. It is a very durable material which can be pulled into place manually with little danger of ripping.

Coating and wrapping of the pipe was done under contract by Rosson-Richards Co., Corpus Christi. Pipe used was 8-in. Schedule 80, 38-lb. pipe with a wall thickness of 0.438 in. The operation was carried on at Ellander Ferry, 10 miles south of Sulphur, La., and the pipe was then transported by water to the launching site. The launching site is at Joseph Harbor Bayou, near the shore terminus of the line. The pipe is tested with a holiday detector by the coating and wrapping contractors at their yard, and then once again at the launching site.

Another major problem to be considered in the laying of the line was that of barnacles. Alcoa learned from its Matagorda Bay experience that the best of wrappings will not prevent these marine creatures from clinging to underwater lines. Ledford remembered from previous experience in Trinidad that barnacles are never found below the mud line on pilings. Further investigation of marine biology revealed that barnacles live on plankton which are not found in mud. Hence, he deduced that the safest way to eliminate barnacle trouble was to bury the line.

The decision to bury the line automatically created another problem. What method could successfully bury pipe several feet below mud in 30-40 ft. of water? A check of pipe-line contractors revealed that Sammy Collins of Submarine Pipe Line Co. had



OFFSHORE SECTIONS JOIN.—(Left) Welder perches on special platform on side of LCT work boat. With the help of a lineup clamp, he is welding together two 4,000-ft. pipe sections which have been towed into place. LOWERING AWAY.—(Right) After completion of weld, sideboom and crane lower pipe onto gulf bottom.

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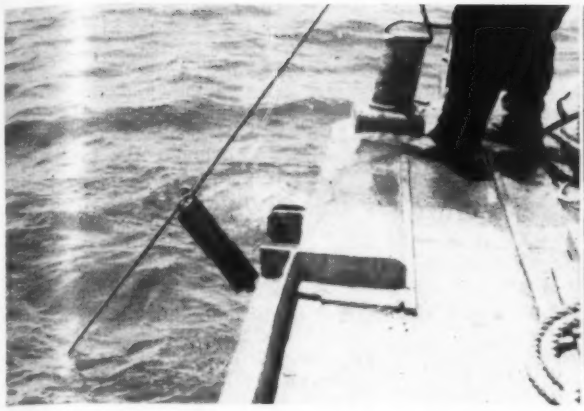

CUTTING LOOSE.—(Left) This line cuts loose the oil drums which floated the pipe into position. It is attached to a special cutting tool which frees the drums. ASSEMBLY LINE.—(Right) All pipe for the system was strung out on shore, in parallel rows of 1,000-1,500 ft. for welding.

developed a patented hydraulic jetting device which could do the job. Hence, the laying job was awarded Collins' company.

The Collins jetting device is designed to dig a trench, and backfill over the pipe, **after** the entire length of line has been laid on the gulf bottom. The device is mounted on pontoons. In operation, the pontoons are filled to the point where they barely lose buoyancy. It is operated from a tug-towed barge on which three medium-sized water pumps are mounted. The device has rubber followers which allow it to travel along the submerged pipe without damaging the wrapping and coating job.

Jets on the device direct water under pressure at the gulf bottom to dig the trench for the pipe. The jetting is so controlled that it throws mud back to cover up the pipe as it moves along.

Collins has used his process in Matagorda Bay and Copana Bay prior to the Marine Gathering job. On one job where the bottom was hard clay, the equipment dug a 5-ft. ditch in one pass down the pipe. It is expected that a 5 to 6-ft. ditch will be dug for the gulf job.

Marine Gathering's line is also being protected cathodically. This work is being done by Cathodic Protection Service of Houston. The ground bed is being installed on land at the shore terminus of the line and a bed of anodes are being placed at the sea end of the line on Pure's drilling platform. Pure has already cathodically protected its steel piling platform. So to keep the two protection jobs entirely separated, an insulating flange is being placed at the platform end of Marine Gathering's line.

The pipe is tested three times during the laying operation. It is first tested on shore hydrostatically to 2,000 psi. It is tested again after it has been laid on the gulf bottom, before it has been buried. Finally, it is to be tested to 1,800 psi. with gas or air, also before it is buried. Operating pressure of the completed line will be 1,200 psi.

Based on Alcoa's experience at Matagorda Bay, tight connections and square bends in the pipe are being eliminated at the point where the line ties into the offshore drilling platform. Alcoa found that piling platforms sway considerably as a result of wave and wind action. This swaying brings about stress fatigue in the pipe if it has no "give."

To provide a flexible connection, Marine Gathering is putting three Chiksan marine joints in the line. These will permit the line to give as the platform moves. Pure's platform is in 40 ft. of water and the upper deck is 30 ft. above water, hence a very considerable motion could be expected during storms or squalls.

To protect the high-pressure gas line against the danger of rupture from a dragging boat anchor, two precautions are being taken. First, two large piling markers are being installed along the route of the line. They will be placed on 15,000 ft. centers. A battery-operated lantern will be placed on the top of the triangular-shaped piling markers. On each of the three sides will be a sign reading "Danger—High-Pressure—Do Not Anchor." The second precaution taken has been personal visits to ports in the area to warn the fishermen that a high-pressure gas line is being installed.

For the actual laying of the pipe,

TESTING.—(Left) After being welded into 1,500-ft. sections, each length is hydrostatically tested to 2,000 psi. Next, several of these sections are welded together and towed to the water location. The pipe is tested with air or gas after it has been laid on the Gulf bottom. HAPPY!—(Right) Pleased with the progress of the "world's first offshore gas line" are Robert C. Ledford, Marine Gathering Co., Houston, and Sammy Collins, Submarine Pipe Line Co., Port Lavaca, Tex.

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a fleet consisting of a war-surplus LCT (105-ft. landing craft), a 750-hp. tug, and two war-surplus 30-ft. diesel carft are being utilized. A crane with a 60-ft boom is located on the bow of the LCT to handle the pipe.

The 8⅝-in. pipe is being fabricated on shore in sections ranging from 1,000 to 1,500 ft. in length. For easy handling, each string is placed on launching rollers before being pulled into the water so that it can be pulled out lengthwise. Sections of around 4,000 ft. in length are being put together for towing to the offshore laying area.

To keep the strings afloat while they are being pulled into position, pontoons made of 55-gal. oil drums are being used. The oil drums are attached to the pipe by steel straps which are welded in place. Collins has devised a special cutting tool to cut the steel straps loose after the pipe has been towed into place and is ready to be cut loose. A Fiberglas rock shield protects the pipe wrapping from the barrel floats. In brief, the special cutting device consists of a long lever arm with a bridle to which a rope is attached. Cork floats are placed on the rope so that the rope can be reached from the water surface after the pipe has been dropped to bottom. One man can operate the cutter by a simple tug of the rope after he has retrieved it.

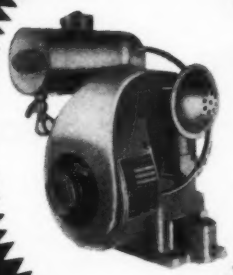
Some trouble was experienced during initial laying operations with collapsed barrels. The pressure in 40 ft. of water collapsed the barrels after the pipe had been lowered to bottom. To overcome this, the contractors put a valve in the barrels and pressurized them with 10 psi. of air. This successfully prevented the collapse of the barrels and had an insignificant effect on their buoyancy.

Welding of the towed sections is accomplished aboard the LCT. First, the craft is anchored in four directions. Then the crane in the bow is used to pick up the two ends of the pipe and they are tied off on the LCT. A catwalk has been erected on the side of the craft for the welder to work on. He cuts off the overlap of the two ends and then welds the pipe up.

Control of the laying operation is facilitated by the use of modern communication equipment. A short-wave radio is available on all boats and a public-address system has been set up on the beach to control operations at the launching site.

A procedure has been worked out to repair the buried line in the event that leaks or other difficulties occur. A diver will be sent down to find the trouble spot. He will tie a yoke around the line and a barge-mounted crane will then free the line from the mud by alternate pulls. It is interesting to note that the 8⅝-in. line is

choose



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Here are just a few of the superior construction features which make Lauson the Long-Life engine: Connecting rods have replaceable crank-pin bearing liners.

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much more limber in water than in air because of the buoyant effect of the water.

By the last week in August, Submarine Pipe Line Co. had laid 1½ miles of the offshore line. Total length of line to be laid in the Gulf will be 8.44 miles. It is planned to have the line laid and a shore treating plant finished by November 1.

Simultaneously with the laying of the offshore line, a separation, dehydration, and metering station is being built on land to process the gas. It is being located at Tiger Island, 15 miles east of Grand Chemiere. Contractor for the job is Packaged Gas Equipment Co., Houston. Meter and instrument work is being done by M. N. Aitken, Houston, and National Tank Co. is supplying horizontal, four-stage separators which will flash the distillate from 1,200 psi. to atmospheric pressure.

Rollover field, source of the gas for Marine Gathering Co., was discovered by Pure Oil Co. about 2 years ago. However, the field has been shut in for lack of market. There is only one producing well at present; however, a second well is currently being drilled, and a third well is planned. From reservoir information obtained with the drilling of the discovery well, Pure is certain of the presence of an excellent gas reservoir.

The gas is coming out of the present well at 2,600-2,800 psi. at the platform. It is to be passed through chokes and a water knockout before entering Marine Gathering's line at around 1,200 psi. The gas is fairly dry, having a recoverable liquid hydrocarbon content of about 10-15 bbl. per million cubic feet of gas.

Those in charge of the laying of the line have developed a great respect for the Gulf of Mexico. In every phase of the operation something unexpected has been encountered. The unexpected has usually revolved around the gulf. Near Pure's producing platform, the contractors have measured an 8-knot current. This contrasts with the 2 knots which is shown on the marine charts. It is necessary to anticipate parts and supply shortages as transportation is a major problem. It is a 11-mile boat ride to the launching site from the nearest boat dock. From the boat dock it is another 50 miles to the nearest large supply point, Lake Charles.

John H. Blaffer, president of Commerce Oil Co., Houston, is president of Marine Gathering Co. G. Burton Liese, Houston investment banker, is executive vice president and Philip C. Dixon, Tulsa, vice president. The three men own the company and constitute the board of directors.

Submarine Pipe Line Co. is headed by William Bauer as president. Other officers include Sammy Collins, vice president in charge of operations, and James Cryer, vice president.

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Practices and Economics of the

BLOCK METHOD

of transporting by pipe line several grades of oil, gasoline, or other products

PIPE-LINE Section

by W. L. Shannon

W. L. Shannon is general superintendent of pipe lines for Gulf Refining Co., Houston Pipe Line Division. Born in Eureka, W. Va., in 1903, Shannon graduated from high school in 1920 and entered the service of Gulf that same year as a laborer. He studied mechanical engineering through extension and correspondence courses. In approximately 30 years of service with Gulf, Shannon has worked in practically every job in the pipe-line category and has occupied, among others, the positions of district foreman, chief gager, chief dispatcher, and assistant superintendent of pipe lines.

IN pipe-line parlance, blocking or batching means handling different grades of crude oil or products through a single line or system in consecutive blocks. Thus, a 10-in. pipe line, 300 miles long, might have moving through it three 50,000-bbl. blocks of different grades of crude, each separate from the other.

Blocking or batching through pipe lines is not a new development. In the southwest Gulf Refining Co. began blocking light and heavy crudes through its lines shortly after the first Oklahoma lines were laid in 1907, and research reveals that in 1901 the United States Pipe Line Co. batched kerosine and water-white oil through a 4-in. line from Titusville to Wilkesbarre, Pa. Since interbatch contamination was not considered important in these early operations, batching was not a very difficult problem.

Varied Products Delivered

As refining knowledge and processing methods advanced, it became more and more important that the various grades of crudes be kept separated in order that the best products could be obtained from each crude with the minimum of processing and at the lowest possible processing cost. To this end the pipe line companies were charged with the task of delivering, as separate grades, waxy crudes, wax-free crudes, sour crudes, semisweet crudes, sweet crudes, high-salt-content crudes, low-salt-content crudes, and innumerable variations of the above grades, and quite often mixtures of them. Of course, these must be uncontaminated from preceding or succeeding batches or from the tankage through which they must be handled en route from the fields in which they are produced to the refinery where they are processed. Since it is not unusual for a pipe line system to be required to handle 20 or more separate grades of crude, it can readily be seen that most of a pipe-liner's nightmares are generously sprinkled with the fear of contamination.

The simplest way to get the various grades of crude to the refineries without contamination would be to build a separate pipe line for each grade handled, but this method is economically unsound and impractical. For example:

To handle four separate grades of crude, each consisting of 9,000 bbl. per day, for a distance of 50 miles through separate lines would require four 6-in. lines operating under 750 psi., and these lines would cost approximately $40,000 per mile to install at present-day prices, exclusive of pumping equipment. By batching these four grades a single 10-in. line would be adequate, and this could be installed for $21,000 per mile, a saving of $19,000 per mile on piping alone. Station installation costs would be lower also, as one large unit could be used for the 10-in. line, whereas four smaller units would be required for the four 6-in. lines. Operating and maintenance costs would likewise be lower on the single line system than on the four-line system.

Separate Systems

In the foregoing paragraphs batching of both crude oil and refined products has been referred to in a general way. These references do not mean that we batch both crude and refined products through the same lines. Gulf's crude-oil systems and refined product systems in the Houston Pipe Line Division are entirely separate, although in some instances pumping equipment for both pipeline systems is housed in the same stations and operated by the same crews.

The mechanics of batching crude oil and products is similar, but each presents a different problem. To simplify this discussion Gulf's crude-oil pipe-line systems in the Houston Division will be considered first. However, Gulf's crude-oil pipe-line systems are not ideally suited to batching operations.

In our West Texas system we have 6, 8, and 10-in. lines paralleling each other in some sections, and in quite a few sections there are 8 and 10-in. lines paralleling each other. As flow velocity through each size line is different, this situation presents quite a problem in timing the arrival of the batches in the different lines. It is often necessary to turn the different lines into separate tankage until the displacing grade arrives in all lines. On a single-line system, or a multiple-line system where all lines are the same diameter, this problem is not encountered. This same situation is also true on Gulf's Light Oil system and Coastal systems, although not to such a great extent.

Batching Operation

A typical batching operation on the West Texas system would be approximately as follows:

Midland station, the accumulating point for oil from the West Texas fields, is pumping sour West Texas crude and it is desired to give a 70,000-bbl. block of O'Brien - gasoline mixture to Roscoe, which is the delivery point for the Sweetwater refinery. First the dispatcher must be certain that Roscoe has enough West Texas stock to keep pumping south to Port Arthur while receiving the O'Brien mixture for Sweetwater, or he must slow down Roscoe operations to accumulate this stock before the O'Brien mixture reaches Roscoe. This

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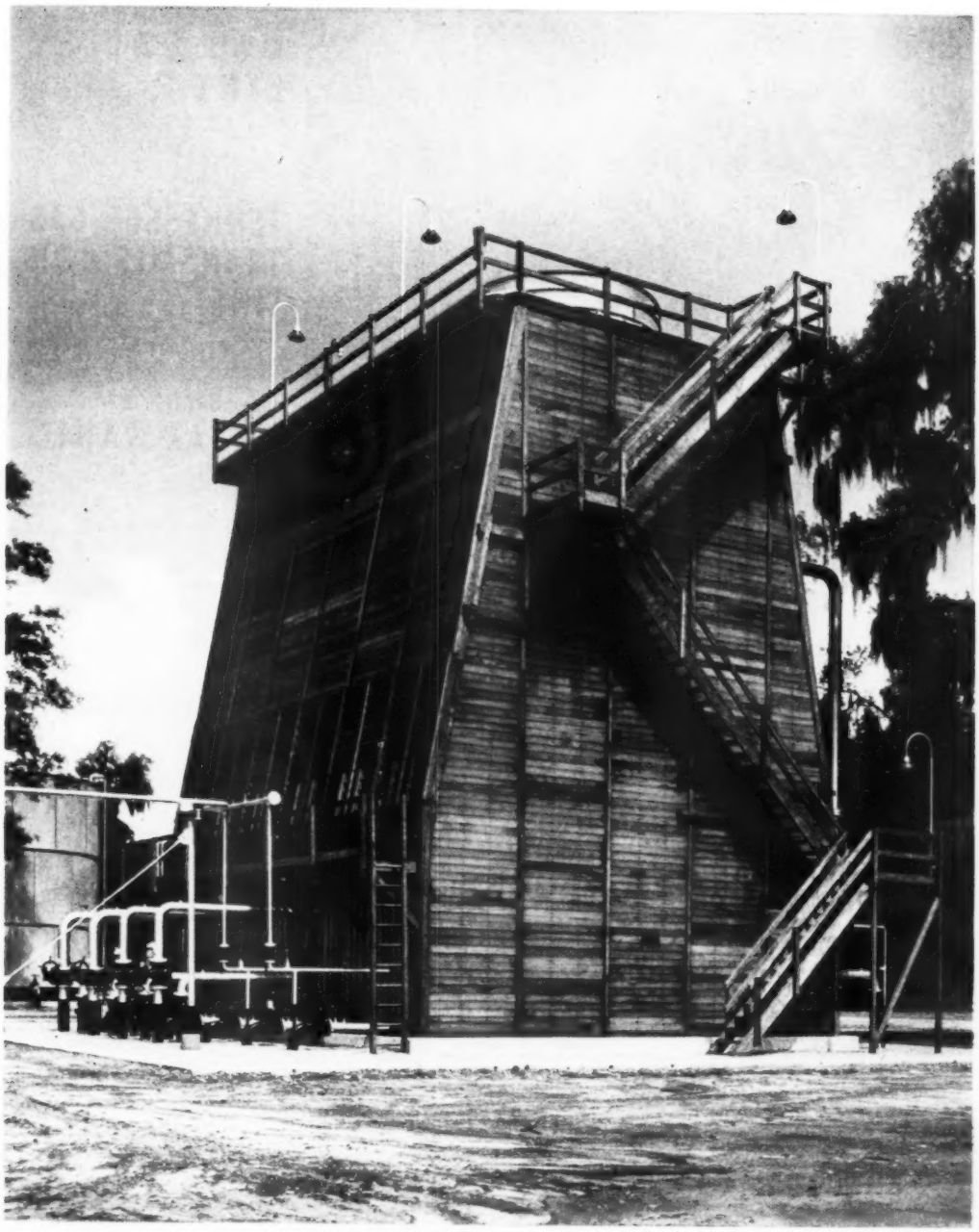

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TENNESSEE GAS TRANSMISSION LINE

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Mid-Valley Pipeline Company will construct and operate a 1000-mile crude oil pipe line from Texas to Ohio. The proposed pipeline will be operated as an inter-state common carrier and will be one of the largest crude lines in this country.

WESTERN is furnishing the Shell and Tube Jacket Water Coolers for the engine driven pump stations on this Mid-Valley line

Full capacity of the line to Cincinnati will be about 150,000 bbl. a day, with a capacity of 140,000 bbl. a day at the Lima terminus. The project includes construction of seven main pumping stations, two spur-line pumping stations, and four oil terminals, as well as the laying of 1000 miles of pipe.

WESTERN FURNISHES HIGH PRESSURE GAS COOLING COILS FOR TENNESSEE GAS 1950 EXPANSION PROGRAM

Continuing its expansion program, Tennessee Gas, in 1950, will extend its existing system by construction of approximately 395 miles of 26-in. main line from northeastern Kentucky to the vicinity of Buffalo, New York; construction of 909 miles of second and third loops along the existing main line in Texas, Louisiana, Arkansas, Mississippi, Tennessee, Kentucky, and West Virginia; and additional compressor units. The increased capacity of the Tennessee system will be 340,000,000 cubic feet daily.

WESTERN is furnishing the major portion of the gas cooling coils on the TGT system as it did in the years 47-48-and 49.

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done, an order is issued for Midland to discontinue West Texas crude at a certain hour and to start the O'Brien mixture. The dispatcher's order must give the exact time to change grades, the tank number from which the O'Brien mixture is to be pumped, the pumping rate, and the pressure limit to be observed.

Knowing the capacity of the line, and using the Midland pumping rate based on hourly gages received from Midland, the dispatcher figures the time the displacing grade will reach Coahoma, the next station east of Midland, and advises the crew at Coahoma when it is due. Coahoma checks the O'Brien mixture (gravity and color) and reports the passing time to the dispatcher. Since Coahoma is a booster station, only a surge tank is used and the oil does not enter tankage there except in case of equipment failure.

The dispatcher, still using Midland's hourly pumpings, calculates when the O'Brien mixture is due at Roscoe and advises them of this time, telling them what tank to turn it into when it reaches there. Roscoe must test the stream until the O'Brien mixture reaches the manifold, at which time the stream is turned into the tank designated by the dispatcher, the West Texas receiving tank is closed off, and Roscoe continues to pump West Texas sour crude from stock.

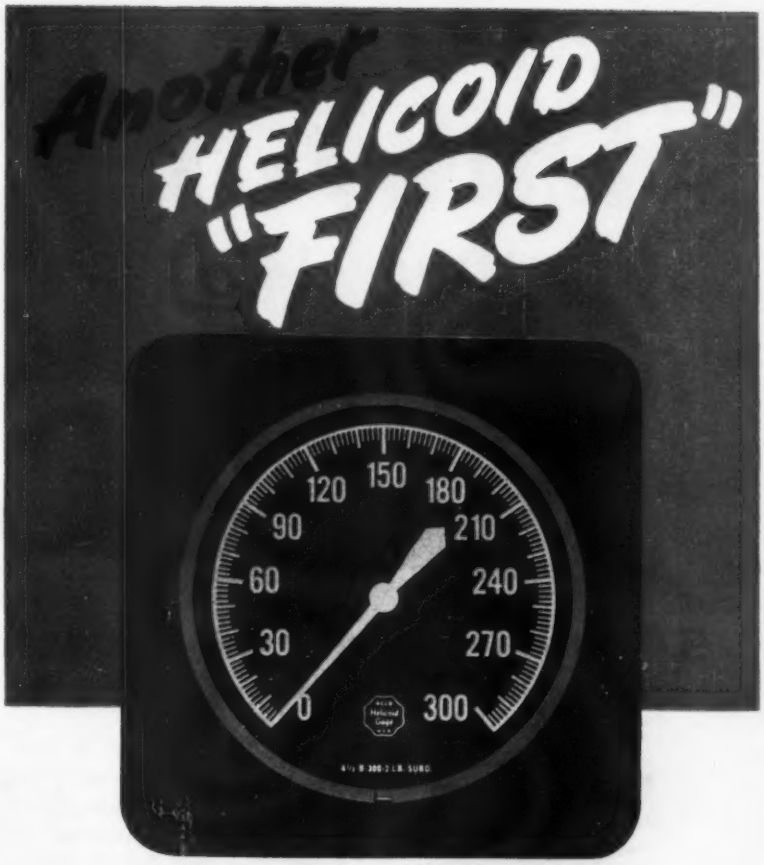
Should the dispatcher require West Texas sour crude out of Midland after the 70,000-bbl. batch of O'Brien mixture is pumped, he issues the necessary orders and the same procedure is followed in working the block of West Texas crude behind the O'Brien mixture into Roscoe.

The above example is probably the simplest batching operation we have. Both the grades of crude mentioned are sour, and interbatch contamination is not too important, although we do exercise every precaution to avoid it on all displacements.

Complicated Batching

In handling batches from Midland through to Port Arthur, Tex., there are often three or four different batches in the system at the same time, which involves a much more complicated procedure. Also, when necessary to put one batch in storage along the line because of a change in refinery schedule and let another batch pass, as is sometimes the case, the procedure is further complicated and requires considerable tankage.

At various times we have batched West Texas sour, Ellenburger, O'Brien mixture, and New Mexico - Yates-Wink through the West Texas systems, as well as blended mixtures. We now have two systems out of this area; one is a single 10-in. enclosed system from Midland to Lufkin to handle sweet crudes, and the other is the regular West Texas sour system from Midland to Port Arthur, consisting of 10, 8, and 6-in. lines and various loops.



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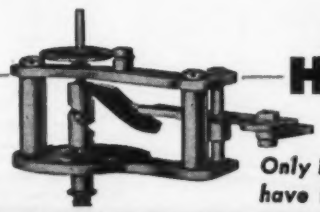

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Through the various Coastal systems we handle "A"-grade and "B-1"-grade crudes, which are the low-cold-test crudes the refinery prizes so highly for wax-free lube oils, as well as the "B-2" crudes which will ruin the "A" and "B-1" crudes if mixed, because of wax, salt, and other impurities.

Controlling the Batching

All controls over the batching of crude through a pipe line system are vested in the chief dispatcher. He must closely check each batch from the time the first barrel enters the line until the last barrel is out. He must know at all times the location in the system of the front end and the back end of each batch, and he must have available a place to store it along the line if the refinery is unable to take it as ordered. He must also regulate his batches to reach the refineries at the proper time to meet their manufacturing schedules. Since it takes on the average of about 10 days to move a batch from Midland to Port Arthur, timing is very important.

As stated before, contamination is the number-one problem in the batching operation. Interfacial mixing between successive batches can be held to a minimum by keeping a packed line that is operating at maximum or near-maximum pressures. A line operated at partial capacity cannot be properly displaced.

Low-viscosity crudes show a tendency to channel into high-viscosity crudes, causing some interfacial mixing of the batches, although not to a serious degree.

Leaky valves are a serious problem in batching, and constant attention by the operating crews is required to eliminate this difficulty. Lines of unequal diameters and loops are other sources of contamination and, as in all operations, the "human factor" is always with us.

Batching Refined Products

Batching of refined products presents many more problems than batching of crude oils, and consequently, much experimenting has been done to perfect the technique. Several companies have set up laboratory experimental pipe-line systems to solve these problems and from these pilot systems has come much of the useful information that enables us today to handle the various grades of gasolines, burner oils, kerosine, and fuel oils through the same lines without any harmful mixing of the various products.

To emphasize the problems in products batching, let me mention a

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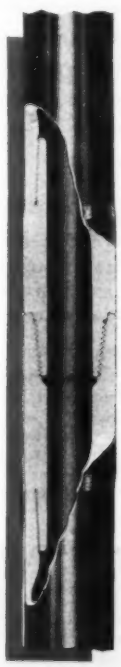

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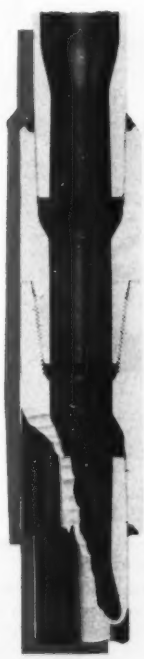

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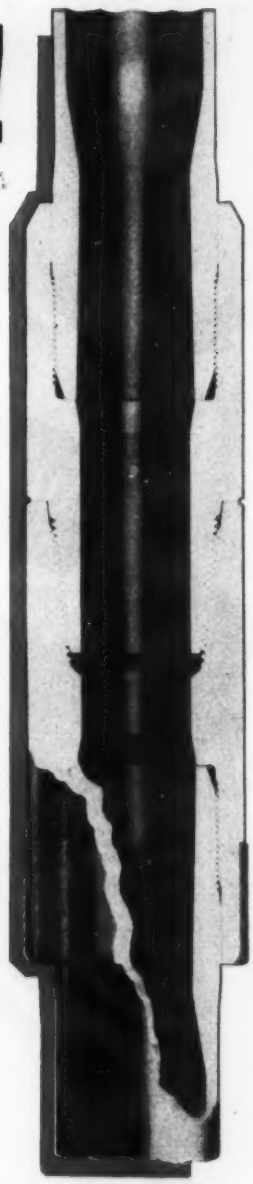

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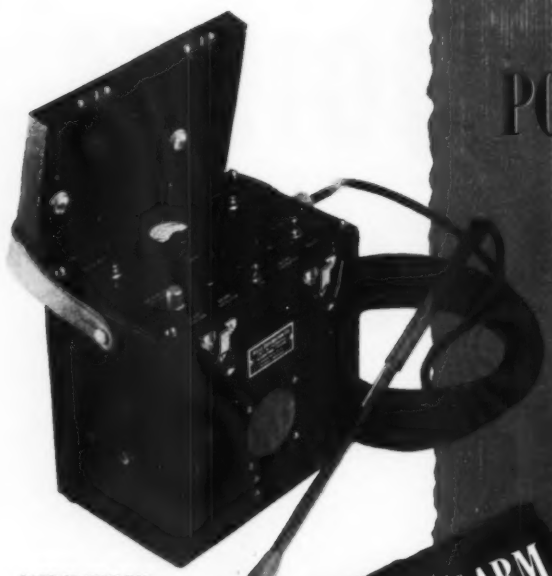

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few of the things that can happen in a products line. Suppose we were batching red-colored premium gasoline, orange-colored regular gasoline and a white recycled gasoline through the same line. I know from experience that a mixture of these products would result in a beautiful, pale-purple product that would be neither premium, regular, nor recycled gasoline, and would not be acceptable to any of the shippers. Also, a mixture between any gasoline and, say, No. 2 Fuel Oil would give the gasoline a high end point and high gum content and would ruin the fuel oil by lowering the flash point below the legal limit.

As another example, water-white kerosine can be ruined by absorbing color from other products and also by absorbing gasoline, which lowers its flash point. Still another example would be the mixing of premium gasoline and regular-grade gasoline, in which case the premium grade would probably come out with a low-octane rating and would not be marketable as a premium product, thereby losing a cent or two per gallon in value. In short, gasolines can be contaminated by other gasolines in such a manner as to change their octane ratings, their colors, and vapor pressures, thereby making them unsuitable for the market for which they were intended and lowering their monetary value. Gasolines can be contaminated by kerosine and heating oils, resulting in increased gum content and a high end-point product that has a reduced value and is often impossible to market.

Heating oils, burner oils, and the various grades of light fuel oils are most susceptible to contamination from gasoline, since a small amount of gasoline will lower the flash point below the legal limit. When this occurs, it is generally necessary to return the batch to a refinery for rerunning, although the condition can sometimes be remedied by rolling the product in a tank with air.

Water-white kerosine is the most difficult of all products to handle without contamination, since it will absorb color from any product with which it comes in contact. It is also susceptible to contamination from gasoline, resulting in low-temperature flashing.

Interfacial Contamination

In products batching, as in crude-oil batching, interfacial contamination of batches is the biggest problem to overcome. Numerous methods to prevent this have been tried. Probably the first was the placing of water spots between the batches, the idea being that the water between the batches would keep them separated and prevent contamination. However, this method did not prove satisfactory, as the water spot was either absorbed by the gasoline or it ran under the lighter product.

Regular line scrapers with rubber disks were also tried as separators but the product behind the scraper bypassed the rubber disks and reached the receiving point ahead of the scraper, due to the friction of the scraper in the line. A rubber swab without knives has also been used, and while it is more successful than the scraper, it also has a tendency to drag in the line premitting the product to bypass when under pressure.

The swab's main usefulness is as a separator when spotting water plugs for repairs to a line or between batches of products when there is a possibility of shutting down a line with two or more batches in transit. In a case of this kind with only static pressure on the line, the products would not bypass the swab and there would be no mixture. The need for some satisfactory separator is apparent if you can visualize a products line in a mountainous country with a batch of gasoline moving ahead of a batch of kerosine. If the kerosine batch reached the top of a descending section of the line at a time when the pumping station shut down, the kerosine, being heavier than the gasoline ahead of it, would run under

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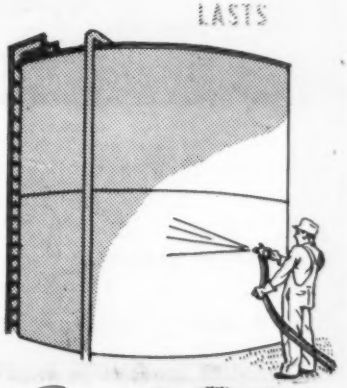

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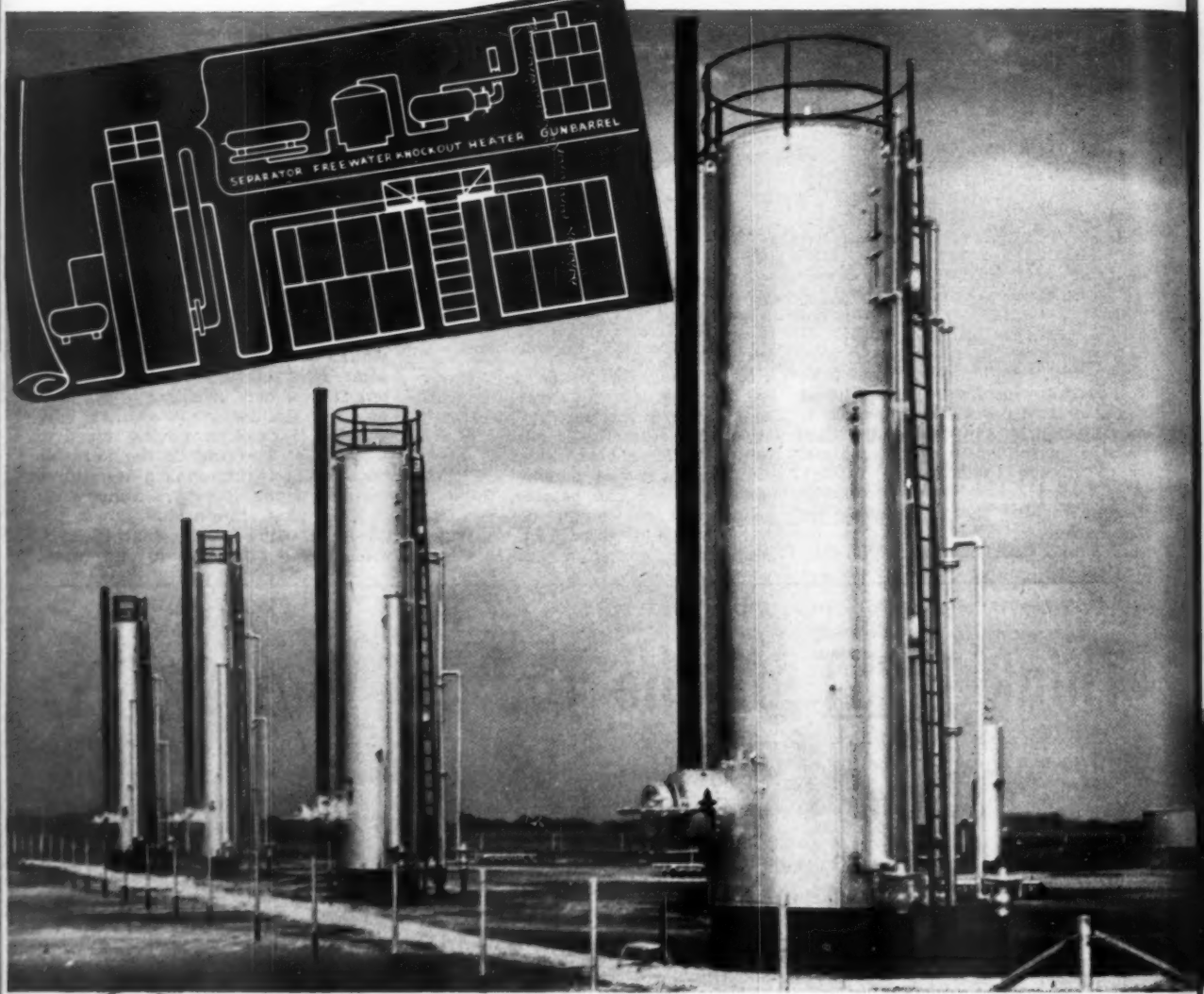

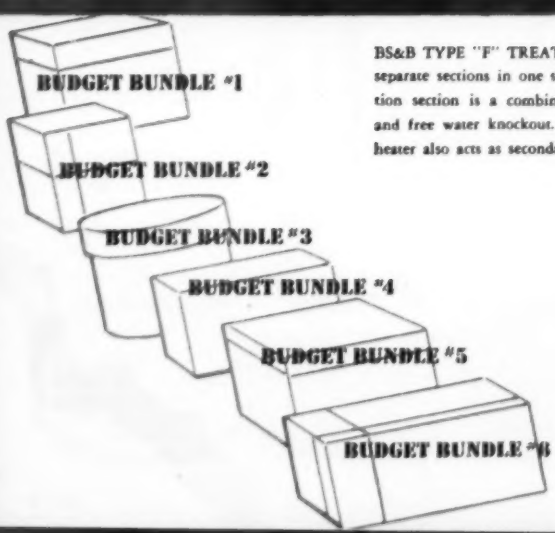

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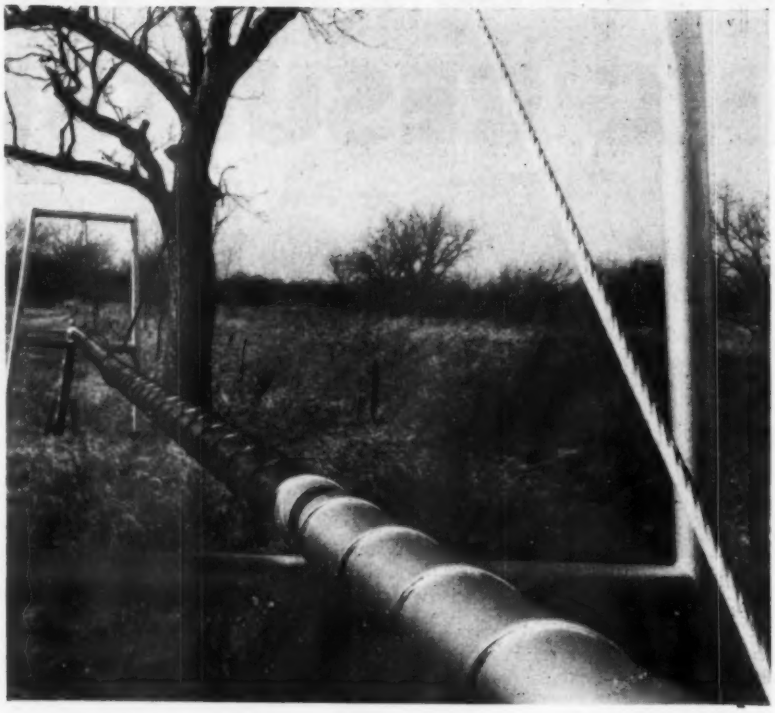

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the gasoline. The results would be a grand mixture, as any products dispatcher can tell you.

Tight-Line Method

The modern tight-line method of product pumping has solved most problems of contamination. This method consists of operating a line or system under high pressure and at full capacity throughout its length, thus minimizing the chances of interfacial mixtures between the batches. To accomplish this, it is necessary to use centrifugal - pump booster stations when more than one station is necessary, and to maintain pressure on the suction of these booster pumps to assure the line being packed at all times. A partially filled line cannot be completely displaced, due to the tendency of one batch to overrun the preceding batch.

Most products pipe lines provide slop tanks at receiving stations to take care of mixtures when they occur, and this mixture is either fed back into the streams at rates too low to impair the quality of the products or is sold as a degraded product. Since normally very few mixtures occur, the disposition of such products is not a serious problem.

Gulf operates two products-pipeline systems in the Houston Pipe Line Division. The first, wholly owned by Gulf, consists of an 8-in. pipe line 325 miles long from our Port Arthur refinery to Eldorado, Ark., with pumping stations at Lucas, Sour Lake, Chester, Lufkin, and Timpson, Tex., Mansfield and Dubberly, Ark. Products storage is provided at Lucas, Dubberly, and at Eldorado. This line has a capacity of approximately 22,000 bbl. per day of all grades of products. It handles premium and housebrand gasolines for Gulf and Socony, and No. 2 fuel oil, which are delivered to Project Five Pipe Line Corp.'s receiving tank farm at Eldorado. While the stations on this line consist mainly of reciprocating pumps driven by diesel engines, the packed-line principle is employed by operating units with an engine-speed governor control activated by the suction pressure at the station, thus a predetermined pressure on the suction side of each station and a packed line between stations is maintained.

At each station along this line gravitometers are used to check the various batches of products by the stations and these tests are augmented by visual tests for color and by spot gravity tests with hydrometers. Recording charts on the gravitometers show any degree of mixture that might occur and are invaluable in the operation of the system. Flash testers are also provided when needed.

The second of these products systems is to Project Five Pipe Line Corp.'s system, which is 69 per cent owned by Gulf, and consists of approximately 150 miles of 10-in. pipe line originating at Eldorado, and terminating at Helena, Ark. The re-

TRIPLE THREAT PROTECTION from MIDWESTERN

MIDWESTERN continues to serve the pipliner and the pipeline industry with its trio of great underground pipe protectors . . . **COROMAT** . . . **KAPCO ROCK SHIELD** . . . and **GLASFAB**. These three outstanding products, each one the **BEST** in its field, offer triple-threat protection against the industry's greatest enemies . . . corrosion and rock damage. As always Midwestern continues to **BUILD** its service to facilitate the handling of the pipeliner's problems.

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A hydrocarbon thermoplastic impregnate Fiberglas cloth, **GLASFAB**, with its heat and moisture resistance, high tensile strength (92 lbs. per in.) and porous characteristics, is a new and valuable addition to the pipe hand-wrapping field. Used extensively for hand-wrapping field joints, field repairs and for machine-wrapping on river crossings and "hot lines", **GLASFAB** is soft, pliable and non-irritating to the hands. Available in widths from 2 to 36" and in lengths from 150 to 2000 feet. A Midwestern brochure gives all particulars, available upon request now.

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For complete elimination of breakage under normal field conditions dope men on line jobs throughout the country are now looking to the new Parallel Reinforced Coromat underground pipe wrap. Made by Owens-Corning this outstanding Fiberglas wrap is of consistent quality, heat and moisture resistant, no patching or splicing, is of high porosity and comes in rolls of 75, 400, 800, 1000, and 1200 ft. lengths. Coromat has greater tensile strength because of the tough Fiberglas yarns, laid ⅜" apart parallel to the length of the wrap. High wrapping speeds plus use of the longer 1200 ft. rolls are now possible with Parallel Reinforced Coromat from Midwestern; specify it on your mill and yard work as well as your "over the ditch" jobs.

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ceiving tank farm and the initial pumping station is at Eldorado, with electrical centrifugal booster stations at Warren, Star City, and DeWitt, Ark. The loading terminal is at Helena on the Mississippi River. This system, built in 1942, has a capacity of approximately 54,000 bbl. per day, and from its completion in 1942 to May 1, 1950, had handled 108,799,686 bbl. of refined products and is operating at full capacity at the present time.

Through this system are transported products for Gulf, Socony, Lion Oil Co., Pan-Am Southern, Triangle Refineries, and Premier. Ten products are currently being batched through this system. These are: 88 and 90-octane premium gasoline; 82 and 84-octane regular or housebrand gasolines; 82, 84, and 88-octane recycled gasoline; kerosine; No. 2 fuel oil; and No. 2 burner oil. Separate tankage is provided for each grade at Eldorado and at the Helena terminal.

This line is ideally suited to batching since it is a single line with centrifugal pumps for boosters. It is operated on the packed-line principle on all displacements, hence very little trouble with contamination is experienced.

A tank is provided at each booster station, and is connected through a relief valve setup to the main line on the low-pressure side of the booster. In case of power failure, these valves unload into the tank until the booster station is back in operation. These tanks are always pumped "dry" before another grade of product reaches the station.

Batching of products through the above two systems was the Houston Pipe Line Division's first experience in handling refined products, and many anxious days were spent in developing methods and equipment properly to do the job. Other products pipe lines were started about this same time, and through the interchange of ideas the operation has been worked out to such a degree that contamination to the extent of impairing the quality of products is very rare indeed.

More problems are encountered than are discussed in this paper, but the general principle of our batching operations is substantially as given here. We are constantly endeavoring to improve our methods and feel that we will be able to handle any problem that may arise in the near future.

BOOKS

CRUDE OIL IN GERMANY. By Dr. H. Hassman. Published by v. Hernhaussen K. G., Hamburg, Germany. 94 pp. DM 3,20.

This book, published in German, deals in six chapters with the location of crude-oil deposits, the technical aspects of crude-oil production and refining, the history, the regions, the importance, and the problems of German crude-oil production. A detailed statistical section with numerous tables, maps, and biographical data supplements the text.

Scenes along Associated's 75 mile spread of 30" natural gas pipeline through Maryland's rugged terrain.

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HOUSTON, TEXAS

Aerial view of Ponca City tank farm near Continental Oil Co. refinery and office building.

Continental Oil Co. Installs

REMOTE READING GAGES

at large Ponca City tank farm

by F. C. Whiteside

THE purposes for which storage tanks are gaged in the petroleum industry may be roughly divided into three classes:

1. To establish accurately the quantities of oil in a tank at the beginning and end of a movement into or out of it for the purpose of transferring custody from one party to another.

2. To register the current movement of a stream of oil into or out of a station or terminal for maintenance of a continual check on the volume and good order of the stream.

3. To determine from day to day volume changes from evaporation or other causes of oil in standing storage.

Gaging for transfer of custody is the most important, and it has been subjected to the greatest scrutiny. Varying intensity of interest and attitudes has developed many conflicting opinions regarding the accuracy of gaging methods. Sampling and temperature measuring share honors with physical measurement methods as bones of contention.

The registration of current pumpings or current use of oil occasions most of the gaging activity. Working tanks in this service are gaged every hour. Thus when it is necessary to go out to, or up on, tanks to gage them, all the weather that occurs in all seasons of the year will have to be encountered.

Consequently "boilerhousing" sometimes occurs with the insertion of gage readings on the records at what it would be from the expected rates of pumping without going out to take the gage measurement. Oldtimers probably invented the term in the days of steam pumping, to denote having stayed by the boilers where it was warm and dry instead of breasting perhaps a blizzard to attempt to secure the hand gage necessary to give the dispatcher his hourly check.

Aside from the difficulties with manual gaging specifically implied in the preceding discussion, hand gaging is subject to other inherent limitations:

1. Debris may hold the plumb bob

PIPE-LINE Section

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You can't protect yourself against a mid-winter storm with a light summer suit . . . and you can't protect your fuels and lubricating oils with inadequate filters. It's as simple as that. Yet, there are some men who try. They try because they think they can save a few pennies, but instead of making a saving, sooner or later they lose their shirts . . . right out from under their linen suits.

When you're in the market for filters . . . it pays to ask a few questions. How much dirt will the filter actually stop? After it stops the dirt, can the filter hold it? Is the element designed to filter really *dirty* oil, or just *clean* oil? Is the element designed so that its surface will continue to provide efficient filtration over a reasonable period of time, or will it quickly become clogged and coated and cease to serve its purpose? Is your particular job adequately performed by just one filter, or should it require more than one? And last but not least, are you getting the *right size* filter to give your equipment sufficient protection?

Winslow elements are built to filter *dirty* oil, to eliminate *the dirt that hurts.* They aren't laboratory filters. They are filters built for hard, day-after-day service in actual operation. They save you *dollars,* not *pennies.*

Winslow Filters eliminate the largest particles of dirt first, and then progressively catch and *hold* smaller particles as the oil passes inward toward the center core. There is no premature clogging, no buckling of the element, allowing dirty oil to by-pass it.

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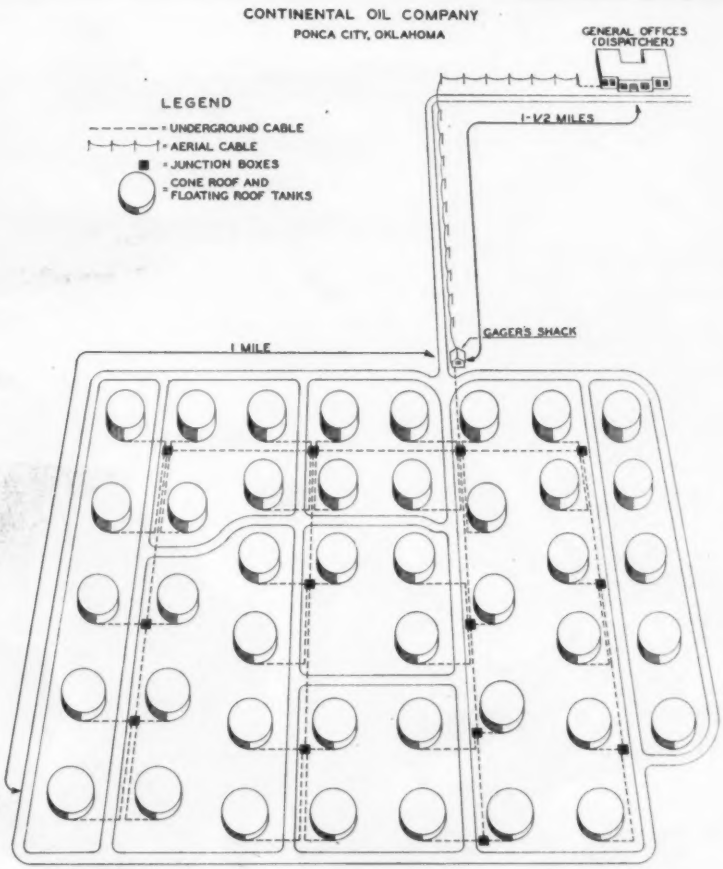
F. C. Whiteside, chief engineer, Continental Pipe Line Co., worked for Oklahoma Pipe Line Co. before and after studying for his degree in electrical engineering from University of Oklahoma. Subsequently he was engaged in operations of other companies including Ajax Pipe Line Co., Carter Oil Co., Standard Oil Co. of Venezuela, and Plantation Pipe Line Co. On March 1, 1950, he went from being assistant to division chief engineer of Interstate Oil Pipe Line Co. to his present position.

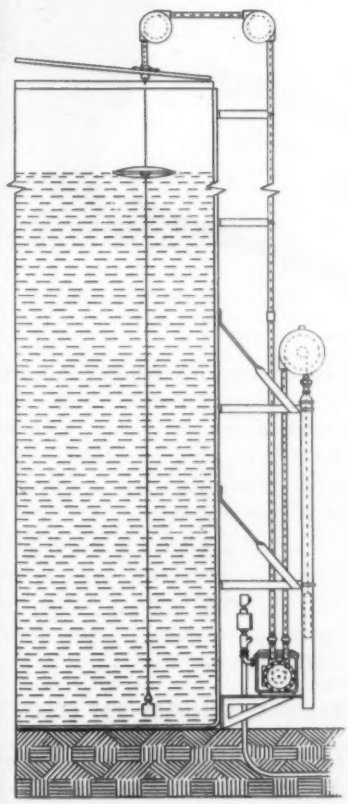
on the end of the gage line off the bottom.

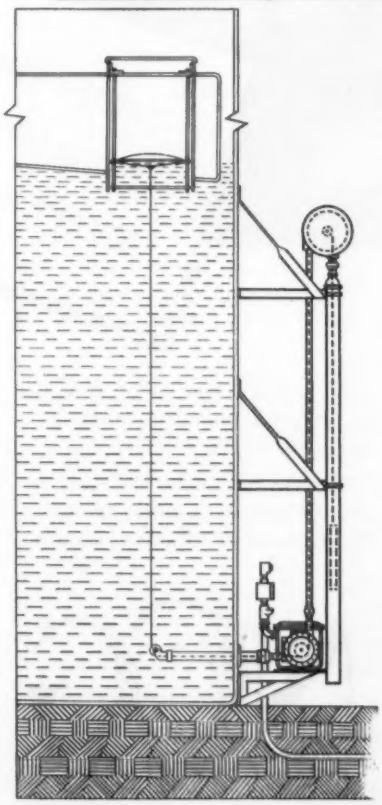
2. The bottom may change level locally by buckling as its liquid height loading increases or decreases.

3. Practically all tank bottoms of any size are built of lapped steel. The plumb bob may strike the top plate of such a lap on one gage and the low plate the next.

4. When taking a gage, the line must be let down until the plumb bob is felt to have touched the bottom. Slacking of the line and different sensitivities of gagers are sources of errors.







Above: Cable installations to serve remote gaging facilities for tank farm. Left: Installation of float and transmitter equipment for remote gaging of two types of tanks: (left) for cone-roof tank; and (right) for floating-roof tank. The transmitter (at lower right) outside each tank in the illustrations, functions with a magnetic drive mechanism which transmits indications of float positions.

5. B.s. accumulations in the tanks can muffle the feel for the bottom or prevent its being reached at all.

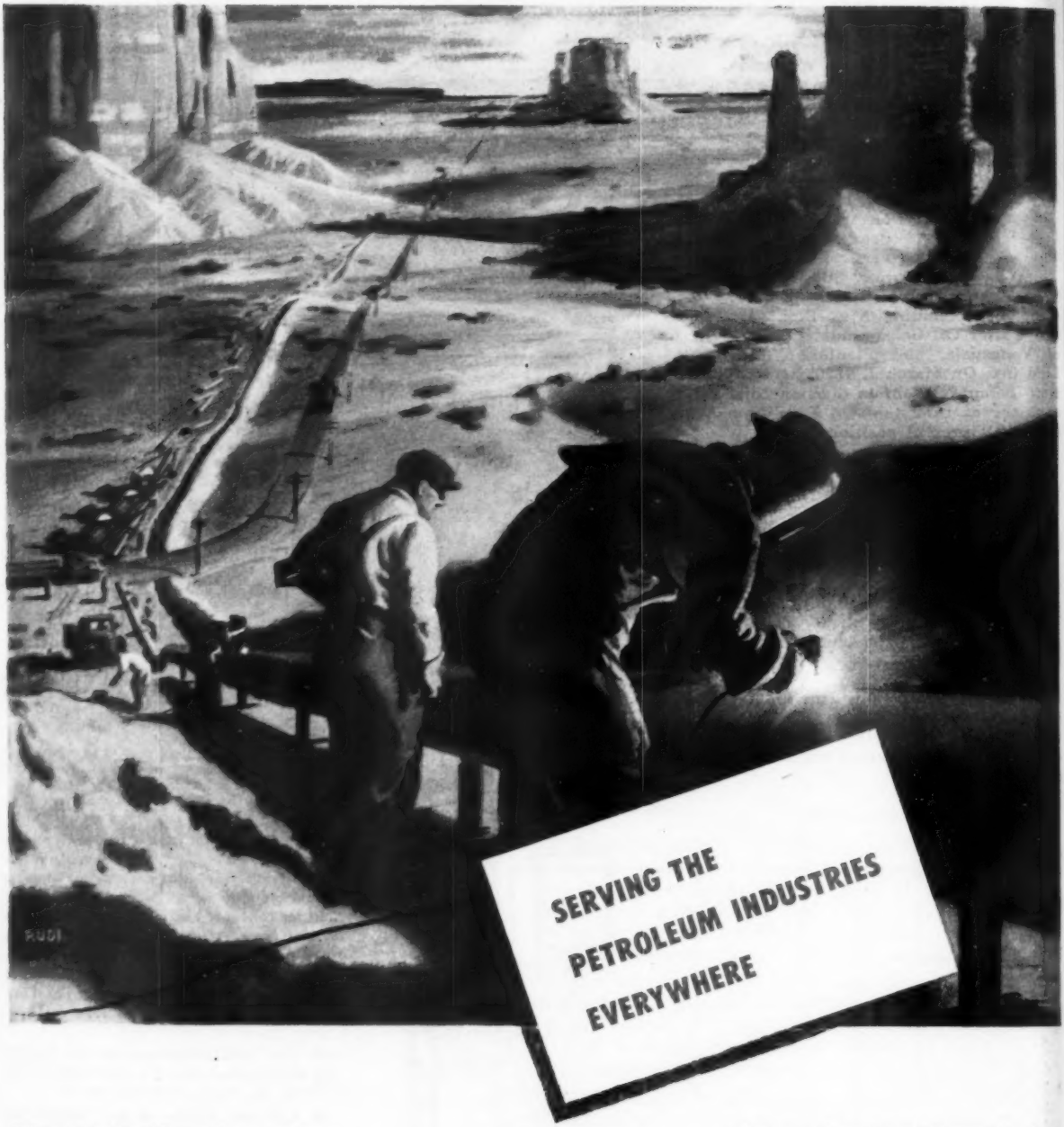
6. Ripples from large incoming streams may cause splash on the tape.

7. Capillary action may cause the oil to ascend the tape.

8. The necessity to gage several tanks each hour at one location may make estimates necessary anyway on account of the time it takes for the gager to go the rounds.

9. The continuing maturity of the oil industry finds many of its employes advancing into middle age in which heart conditions sometimes are prevalent and negotiating stairs, sometimes several times an hour, 40 ft. high (about four stories) and some higher, cannot be expected to ease these physical conditions.

The list could be made much longer, but these are representative of the reasons why many in the petro-



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leum industry have for years entertained the idea of replacing the manual method of liquid-level gaging of oil-storage tanks with automatic equipment. Higher oil prices focus ever-increasing attention toward possible errors in gaging practices and ever-higher labor costs tend to encourage improvement in the process. In recent years pipe-line rates of flow have increased to such an extent that oil in large tanks is sometimes moved at more than an inch per minute with perhaps remote-control switching of the streams, so that manual gaging of the current status of tanks' contents begins to lose its practicability.

Several automatic gages have been produced, and though they may not have answered all phases of the gaging problem, they have answered some of them and may win over most of the others. Some of the characteristics of a good automatic gage are:

1. Economical installation and maintenance cost.
2. Ease and economy of extension of gaging service to other tanks at the same location.
3. Accuracy of the gage reading.
4. Reliability as to maintenance of gage setting.
5. Maintenance of gage setting during periods of power outage.
6. In sour-crude service, resistivity of the exposed parts to its corrosive attack, and
7. Ability to seal off completely the electrical wiring and contacts from even minute amounts of hydrogen sulfide.
8. Centralized reading of the gage scales, and
9. In some cases, the ability to read the gage scales at more than one centralized point.
10. Also facility for reading the gage locally at each tank.

Late in 1948 Telematic remote and local reading gages were selected for installation on five tanks in sour-crude service at McPherson, Kans., and early in 1949 they were ordered for the tank farm at Continental Oil Co.'s Ponca City refinery. Thirty-eight of them were installed on cone and floating-roof tanks handling various types of crude oils in a tank farm about 1 mile square.

Gage readings may be taken at individual tanks or on an indicator panel in the gager's office near one corner of the tank farm. A duplicate of this panel is located in the dispatcher's office 1½ miles away. These panels make liquid-level readings of any of 38 tanks available instantaneously to dispatcher, gager, or gate switchers.

This gage uses the step-by-step contractor principle, operating at 30 volts, d.c. maximum at 1 amp., and standard aerial or underground telephone cable serves as transmission line. The system is approved by Underwriters' Laboratories for use in hazardous locations and the components and materials have satisfactorily withstood the corrosion and atmospheric conditions.

One unique feature of these gages permits a highly satisfactory installation on floating-roof tanks. A serious problem is ordinarily presented when these tanks must be gaged by tapes or wires operating above the pontoon in the highly corrosive vapor space. Oscillation of tapes and floats is also a serious problem on gages installed in this manner. These faults have been overcome where the gage tape is introduced below the floating roof.

Although tanks must be out of service for this type of installation, present plans call for the conversion from top entry to bottom whenever cone-roof tanks should be out of service or changed to floating-roof tanks.

The use of conventional telephone cable for transmission line permits the use of sound-powered phones for communication throughout the tank farm. Plug-in stations are available for portable phones at all tanks, junction boxes, and indicators. This has proved to be a valuable asset to tank-farm maintenance men or construction crews as well as normal operating personnel.

The electric gages have resulted in considerable savings of labor, and in addition, gagers have time to perform some maintenance work which would otherwise require additional labor.

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MEMBER FEDERAL DEPOSIT INSURANCE CORPORATION

Mid-Valley Operates 1,000-Mile Microwave Relay System

by Dale Samuelson*

CROSS-COUNTRY pipe-line companies find it essential to have immediate and continuous communications available to and from all terminal points and major pumping stations in order to provide complete control of the liquids they move. A combination of telemetering, voice and teletype communications, and remote control should achieve this goal.

Maintaining a communications system that provides safe, uninterrupted flow of gas or oil has established itself as one of the major problems for those who transport volatile fuels by this means. For safety, and for economy, the status of the entire flow including such items as volume, pressure, and delivery rate must be known and coordinated from various central points. Any desired change of flow must be instigated almost simultaneously from many points. As a result, positive and faithful direct communications along the line are indispensable.

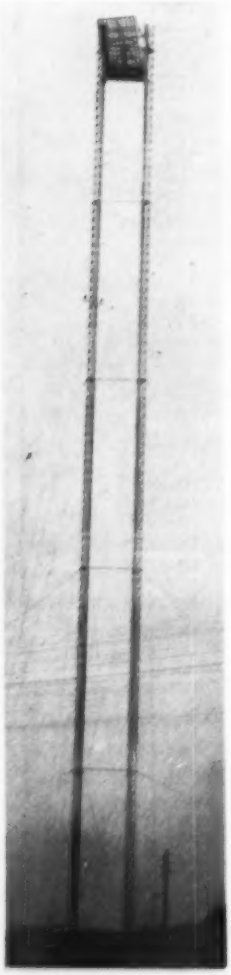
In the past some companies installed their own private overhead telephone lines, while others leased lines from telephone companies. Whichever the case, they found that a strong wind or snowstorm, or a falling tree limb would be enough to disrupt the system. A long line pass-

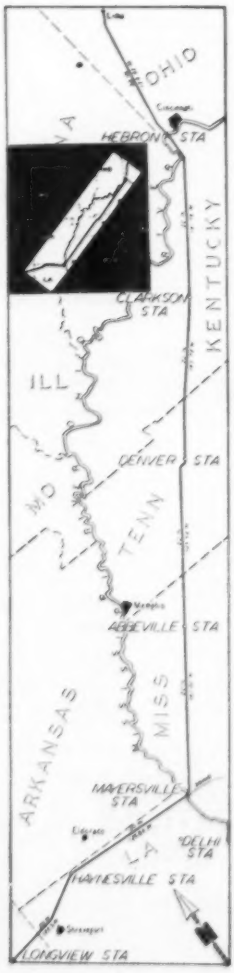
*Technical information center, communications and electronics division, Motorola, Inc., Chicago.

The type of communications system to be used by Mid-Valley Pipeline Co. is known as a "microwave" system. Its name is derived from the Greek word "micro" which, in communications language, means "very small," and denotes a radio system using very short wave lengths. The wave length used in Mid-Valley's system is approximately 4½ cm. (1¾ in.) which corresponds to a frequency of 6,700,000,000 cycles, whereas the shortest wave length used by broadcast stations is 200 m. (655 ft.), corresponding to a frequency of about 1,500,000 cycles.

Microwaves act very differently from radio waves coming from broadcast stations, or even radio stations operating on very high frequencies (V.H.F.) such as used by taxicabs and the like. These longer waves, unlike the ultra high frequency (U.H.F.) or microwaves are not absorbed by buildings, trees, and hills. They will bend around large obstacles, and at night, and even sometimes during the day, they are reflected by a layer of ionized air about 50-150 miles high back to the earth so that stations are sometimes received over distances as great as 6,000-7,000 miles.

Microwaves, however, act much more like light than like conventional radio waves. They will not pass through buildings—a fully leafed tree will absorb much of the wave's energy—and they will not bend around large obstacles. Also, the reflecting layer that sometimes causes the longer waves to return to earth at great distances does not act in such manner for microwaves. The energy of the microwaves, once it leaves the earth, passes on into outer space.





PIPE-LINE Section

Fig. 1—(Extreme left) A typical Mid-Valley microwave repeater tower. At the top is the flat passive reflector.

Fig. 2—(Left) Path of Mid-Valley's microwave relay system from Longview, Tex., to Lima, Ohio.

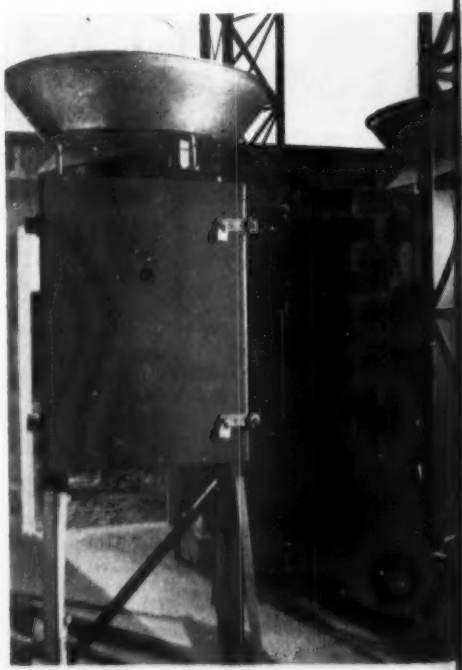


Fig. 3—(Right) R. F. housings within patio built around microwave relay station.

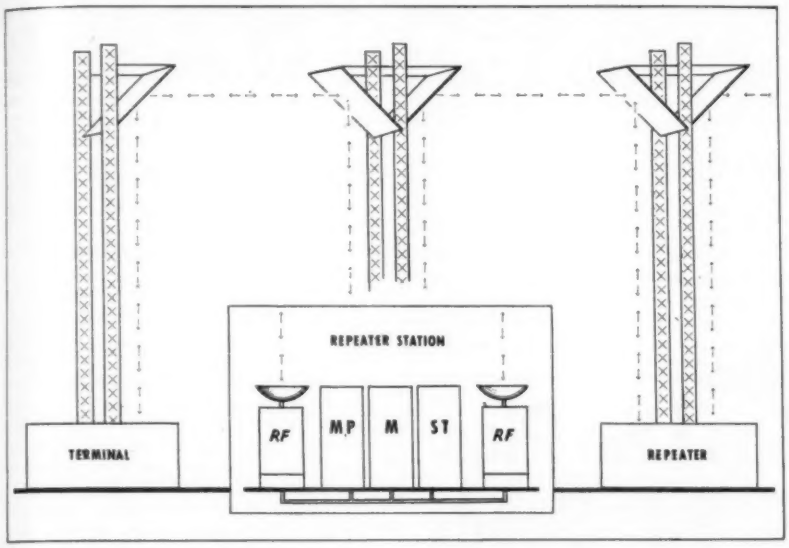


Fig. 4—Stylized drawing of a portion of a microwave relay system showing the route followed by the signals as they are transmitted from tower to tower. RF represents the RF housings, MP is the multiplex equipment, M is the control and power supply equipment, and ST is the standby unit.

ing over all kinds of terrain, furthermore, stands waiting for sabotage, an element that can't be overlooked today.

To keep a private line communications network, operating as reliably as possible inevitably meant maintenance costs. Maintenance work was unbalanced, with the greater part having to be carried out during snow and hurricane season. Crews could look forward to the hardest work during the worst of weather conditions.

If the company rented the lines it was faced with the expense of tremendous telephone bills, high construction costs to isolated sections, and unreliable or inadequate maintenance standards.

Pipe-line people looked for other communications means to fill their needs.

Amplitude-modulated (A.M.) two-way radio over long distances has always been unreliable in any weather, and particularly in severe weather. Frequency-modulated (F.M.) two-radio, using only terminal receivers and transmitters, is impossible because radio waves of the high frequencies follow only straight lines, and therefore, do not have the facility of long-distance communications.

Buried cable also remains too expensive for the few telephone, telemetering, teletype, supervisory control, and associated circuits required by pipe lines. It is economical only when hundreds of circuits are required.

To combat these various inaptitudes of other communication media, Mid-Valley Pipeline Co. of St. Louis, jointly owned by Standard Oil Co. of Ohio and Sun Oil Co., have installed a subcarrier multiplex microwave (ultra high frequency or U.H.F.) relay network. The system follows and protects the company's new 1,000-mile crude oil line from Longview, Tex., to Lima, Ohio. With this form of microwave, Mid-Valley officials can maintain virtually uninterruptible communications along the pipe line.

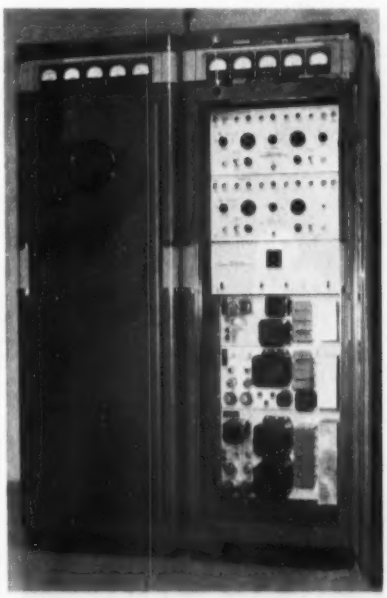


Fig. 5—Repeater power supply and control units on Mid-Valley's microwave relay system. On the left is operating equipment. Door of standby unit at right is shown open.

Microwave relays were developed as a result of research during World War II, and since have been proved to be compounded with the technical ability to give economical and reliable service to pipe-line companies, as well as other organizations such as the railroads.

The Mid-Valley system makes use of those characteristics peculiar to the highest end of the radio-frequency spectrum. Frequencies in this area exhibit the symptoms of visible light such as diffraction, refraction, and reflection. Microwaves move in straight lines and will not follow the curvature of the earth, just as visible light moves. As a result, they can be focused and pointed at a distant object. Relaying these beams, on which are superimposed intelligence signals, results in the formation of a point-to-point radio-communications network—a microwave relay system. (See Fig. 1).

Most Extensive Installation

Mid-Valley's microwave relay installation, which cost $800,000, was designed by Motorola, Inc., of Chicago, with the assistance of Sohio's C. B. Lester and Sun Oil's Charles Burgess. It is the most extensive installation of its kind in the world.

Onto the carrier wave of the system are impressed the signals from two circuits assigned to party-line dial telephones, from three circuits assigned to private-line dial telephones, and from a party-line teletype circuit, in addition to a circuit which carries messages to any Mid-Valley two-way-radio-equipped mobile unit that is within the V.H.F. range of any microwave relay or terminal station of the system.

On each relay station tower along the system is built a remotely controlled V.H.F. transmitter and reception unit for mobile communications. The transmitted signals move over the microwave circuit to the relay tower nearest the vehicle with which communications are directed, where these signals are superimposed on a carrier wave of the Mid-Valley mobile frequency.

The system includes 36 repeater stations spaced 14 to 37 miles apart. Starting at the Longview terminal, the line runs east to near Haynesville, La., to Mayersville, Miss., up northeast to Abbeville, Miss.; Denver, Tenn.; Clarkson, Ky.; to Hebron near Cincinnati, and to Lima as it follows the pipe line. (See map, Fig. 2).

Subcarrier multiplex microwave relay was chosen to span this distance for a number of reasons besides its ability to overcome the bugaboos found in the other communication forms already mentioned.

Microwave relay systems maintain a performance stability not found in other media. Frequency response characteristics, signal-to-noise ratio,

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and output levels of microwave transmission are nearly constant, while land-line characteristics, for instance, vary greatly from day to day due to variation in induced and other types of leakage.

Parts of the Mid-Valley line route are so rough and hilly that wire lines would be almost impossible to install and maintain.

Because the microwave relay system's power can be concentrated into a narrow beam and directed to a distant, but known, reception point, low power can be used, and the beam effect makes it equivalent to powerful transmission from the receiving point of view. Mid-Valley's system uses a 0.1-watt klystron transmitter operating on a frequency of 6,575 to 6,875 megacycles. The received signal strength is equivalent to that obtained from 320 watts of radiated power out of a dipole antenna.

Other microwave systems will be able to use the same frequency as Mid-Valley in the same area and have only to be sure the beams do not coincide. Because of the directivity of such a system, no interference exists as it does when one omnidirectional transmitter operates in the same area and on the same frequency as another.

Receiving and transmissing equipment at the terminals of the system is located in an outdoor weatherproof R.F. housing on the ground beneath the reflector tower. On top each housing sets the antenna plumbing in a 40-in.-diameter paraboloid reflector. Only one antenna is used simultaneously for both transmission and reception. The paraboloid reflector projects the microwave beam, with a 3½° spread, to a flat passive reflector at the top of the tower, at which point the beam is redirected horizontally towards the first relay station, probably 25 miles or so away. Once a beam hits a reflector in its path it is cast downward to the paraboloid reflector and antenna beneath.

Two outdoor weatherproof R. F. housings are installed at each Mid-Valley microwave relay point as shown in Fig. 3. Most of these housings are erected within a specially designed walled-in patio built into the station house. The beam is received and amplified, and then retransmitted from the antenna of the second R.F. housing to the reflector above, and then on its way again to the next relay station. This process continues until the beam, and the signals impressed on it, arrive at a terminal point or the desired intermediate station. (See Fig. 4).

A special wave guide feeds each antenna. Such a guide has many important advantages over a co-ax line because of its cutoff frequency of 4,300 megacycles. Any transmission, no matter how strong, on a lower frequency—including static and lightning discharges — cannot penetrate the receiver. In other words, the wave guide acts as a perfect attenuator for all frequencies below its cutoff frequency.

Thus, complete static-free and noise-free reception is achieved on Mid-Valley's network despite the fact that it can be located with a few feet of a powerful oscillator working on a lower frequency, such as the 250 or 60-watt V.H.F. transmitters, which are used for communications to mobile units and located on the same tower.

Another advantage results from using short lengths of wave guide. The pieces are 100 per cent maintenance free because they have no interconductors, and thus, there is no insulation or braid to burn off. Tuned circuits are built inside the wave guide, thereby eliminating all connections to separate pieces of R.F. plumbing. One transmitter complete with tuned circuit and monitoring circuits consists only of heavy rectangular tubing welded into a single rigid element.

Mid-Valley's network, with a frequency band 10 megacycles wide, contains a dozen subcarrier channels which are continuously multiplexed so that many messages or control circuits function simultaneously without interference from each other. These flexible circuits allow channels to be dropped or inserted at any relay point.

Rain, snow, or sleet has only slight effect on the signals in the 6,575 to

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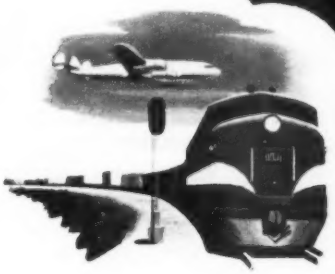
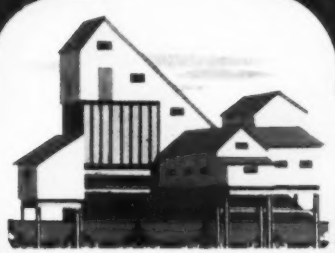
LOGGING

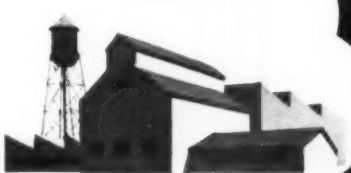


TRANSPORTATION

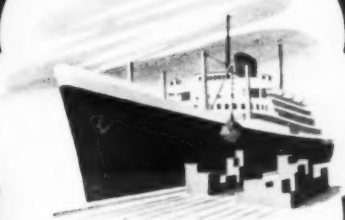


MINING

PETROLEUM



MANUFACTURING



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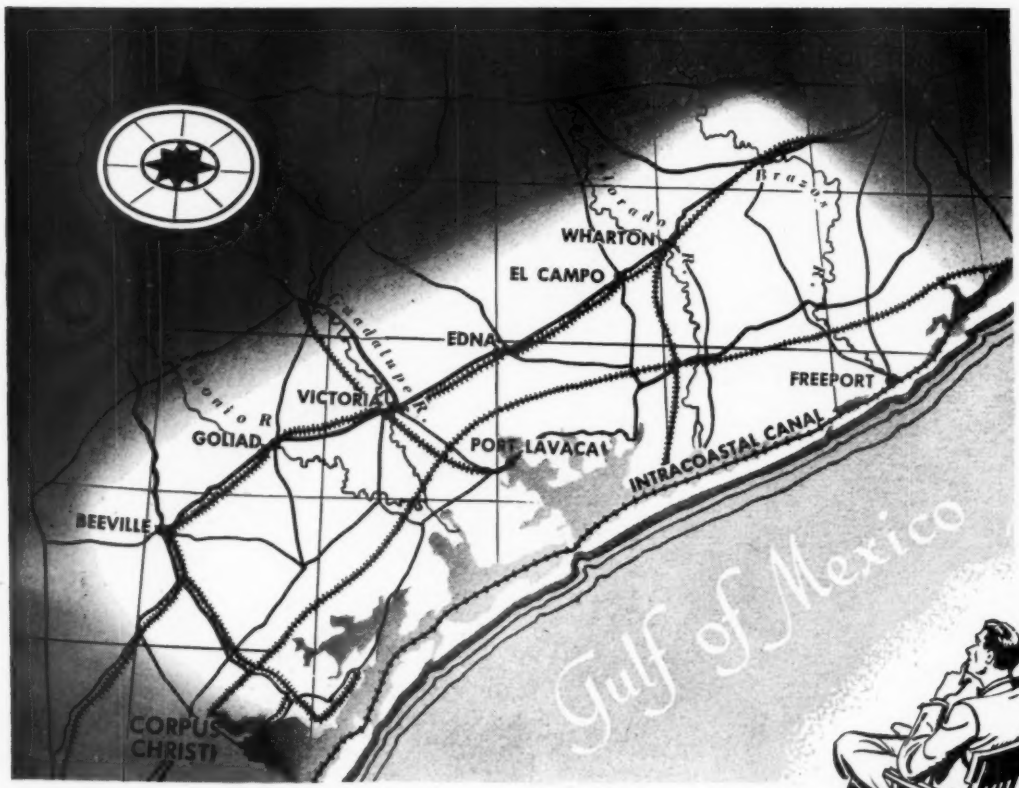

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6,875 megacycle band used in this equipment. Rain will considerably attenuate higher frequency signals of 9,000 megacycles or more. Each parabolic reflector dish contains a built-in snow melter. These melters have been in use on other systems for more than a year and have been proven successful.

The single antenna for both transmission and reception and the 45° flat passive reflectors on the top of the towers of Mid-Valley's microwave communications system were first used by Motorola in practical systems. The antenna and all other equipment are located on the ground and easily accessible for servicing. The flat reflector, nothing more than a sheet of metal perforated to reduce wind resistance, has no cable, no wave guide, and no other conductor leading to it. Once adjusted for direction and locked in place, it needs no further attention.

At each relay station the transmitting frequency differs from the frequency of the carrier on which messages are being received by 120 megacycles. This prevents interference caused by a portion of the transmitted signal being picked up by the receiver at the same station. It also allows for the use of a common antenna for receiving and transmitting simultaneously, a feature achieved by using one - fourth - wave space - type cavity separation filters.

The equipment incorporates a double frequency-modulation system in which each voice channel frequency modulates one of the separate small subcarrier transmitters on frequencies between 120 kc. and 1 mc.

Each miniature plug-in subcarrier transmitter incorporates only two double triode tubes, both 6SL7 type. One triode is a voice limiter, another is an oscillator, the third is a frequency modulator, and the fourth is a cathode follower.

The output of these subcarrier transmitters is collected into one co-ax cable which in turn is connected to the microwave transmitter that frequency modulates the resulting signal with a wide deviation of plus or minus 5 mc.

At a receiving point, the microwave receiving unit, equipped with a discriminator, recovers the subcarrier frequencies, but not the audio frequencies. This video signal then is applied to modulate the transmitter directly in the case of a repeater station, or can be applied to the subcarrier receivers at a terminal station.

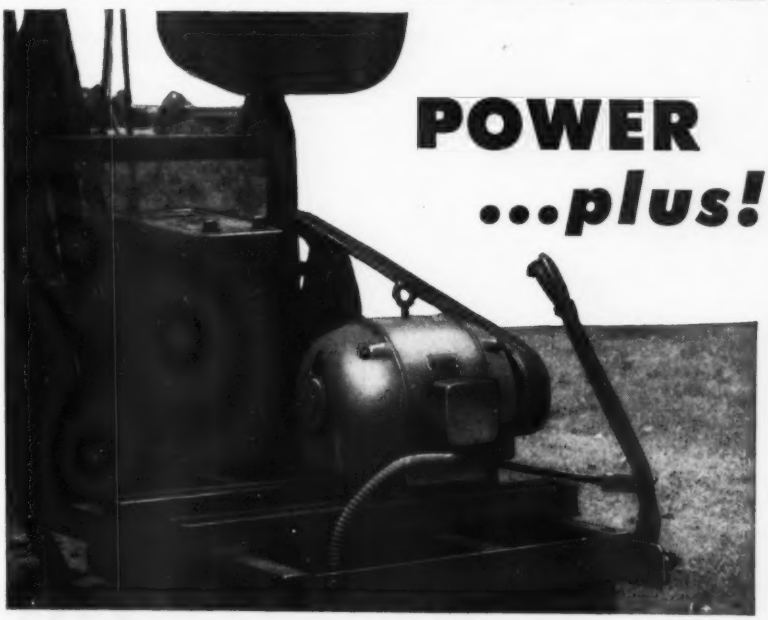
The subcarrier circuits detect the F.M. signals with conventional limiters and discriminators capable of recovering voice frequencies. Distortion and cross-modulation on voice frequencies is held to minus 54 db. (deables) or less. The existence of voice frequencies at the terminals only and not at the repeaters makes possible only minor distortions.

The whole system employs close to 2,000 seasoned radio tubes which are continuously in operation. Each tube has an average life expectancy of 20,000 hours. Once the system has been in operation long enough that the tubes are of all ages, it is expected that one will cease functioning every 10 hours.

It is therefore very important to be sure operation does not cease when one of these tubes fails, and for this purpose complete standby equipment including separate cables and power supplies was built into the network. The R.F. housings were constructed to include two complete transmitter-receiver units, one for regular operation, one for emergencies. Sensing circuits built into the equipment can recognize a failure of any tube or component and automatically switch over to the standby gear with only a few seconds to 2 minutes interruption to communications.

Because of this builtin protection, the system is to be maintained by only four men. These men, each assigned to a portion of the system, will periodically visit the otherwise unattended relay stations, exchange burned-out tubes, and do other preventive maintenance work. Fig. 5 shows repeater power supply and control units with standby equipment.

Mid-Valley's system is so designed that the company can, at any time,



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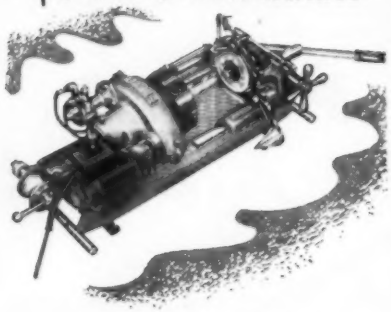

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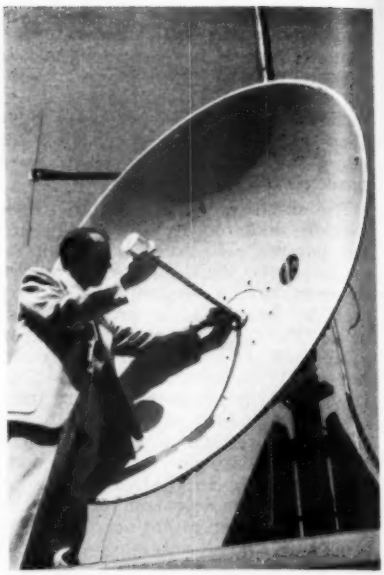
add other electronic circuits. By the addition of these circuits the position of all switches, signals, and valves, and the readings of all important meters can be displayed at any or all dispatch points. The remotely controlled system will be able, then, to provide for adjustment and operation of any number of these valves, switches, or other unattended devices by activating the proper circuits.

This opens up a whole new realm of future possibilities for expansion of the system. Imagine a 22-in. valve somewhere on the pipe line. A man at a central point miles down the line will be able to look at a meter on his control panel and read the pressure in the pipe at a point near the valve. Between the points there is only an unseen microwave beam as a communications media. By pressing a button or closing a switch the valve will slowly close or open as it is directed. For over that unseen beam will have traveled a signal that directs the valve's opening. In the same manner almost any mechanical operation can be carried out.

Across the southern central section of the United States strides this faithful servant for Mid-Valley Pipeline Co. By using this new giant, with its graceful towers lined across the hundreds of mile from Longview to Lima, the company is finding adequate, reliable, and continuous communications possible. A major pipeline problem has been solved.



One of the 114 microwave relay reflectors being built by General Electric for the communications system the company is supplying Transcontinental Gas Pipe Line Corp., to extend over its 1,840-mile pipe line now under construction between Houston and New York. Project engineer M. F. Davis finishes installation of the dipole prior to tests being made at Electronics Park. Longest microwave relay system in the country, the 1,840-mile project is scheduled for completion by March 1951.

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The Internal-Combustion Turbine

. . . in Liquid and Gas Pipe-Line Service

by C. C. Keane*

FOR several decades the evolution and development of power equipment for oil and gas transportation have followed a pattern that has deviated only as a modification from the original machinery introduced early in the century.

The only change has been the introduction of internal combustion for steam in the prime movers' cylinders and in some instances electric power has been used as the energy for pumping. It is admitted stations have become more complex because of the multiplicity of units used but fundamentally they are little different from those that housed earlier single-cylinder units. There are the usual problems of fuel, water, lubricating oil, and starting air supply systems and the ever-present requirement of cooling the engine water either by heat exchange to the pipe-line stream or by atmospheric cooling towers of various designs.

It is true that supercharging or turbocharging and waste-heat recovery have materially increased the efficiency of some prime movers but the cost of station construction in which modern building techniques and materials are used has climbed to levels that are extremely expensive. Hence, it has become essential that the physical dimensions of pipe-line and compressor-station equipment be reduced to the minimum that will dependably serve the system.

Two Sources of Power Energy

There are two sources of power energy that equitably satisfy the need for large power output in a small package: electricity, or combustion applied directly to a turbine. Electric-powered pumping and compressor equipment has been used for quite some time and many of the systems designed today utilize it if satisfactory contractual terms can be arranged. However, in many areas it is not possible to secure power contracts that are firm in their economic approach, and, since the fuel clause as currently interpreted serves only to further increase the cost of power to the consumer, it is not always possible to predict the upper level of the increase.

Electric power, however, is readily applicable to practically any manner of control arrangement and the sequential operations and functions

*Chief engineer, Great Lakes Pipe Line Co., Kansas City, Mo.

that may be chronologically interlocked are limited only to the designer's fancy. The problem of pipeline volume control in liquid carriers using centrifugal pumps with induction motors involves the inefficient arrangement of throttling except in the rare instance when scoop-governed hydraulic couplings are used. In compressor stations, the inlet pressure may be throttled to reduce line throughput when using centrifugal or axial-flow compressors.

The prime mover which is yet in its infancy but will, in time, revolutionize liquid and gas-line systems appears to be the internal-combustion turbine. The development of the axial-flow compressor, as a component part of the turbine, has introduced improvements that are readily applicable to this equipment when used in the transportation of fuel gas.

Use Spurred by War

Internal-combustion turbines, frequently called gas turbines, received their greatest impetus in the latter part of World War II when the jet plane made its appearance. While it is recognized that for aviation use the designer bends every effort towards developing the maximum thrust from what remains of the jet blast after it has surrendered sufficient energy to power the axial compressor, it is also a fact that the thermal efficiency of the over-all plant is low.

In industrial application, many technical problems remain to be solved. Perhaps the most pressing of these is a metal that will retain its physical and mechanical characteristics at the elevated-temperature levels at which turbine fire chambers operate. Another is a dependable heat exchanger. Desirable efficiencies may only be attained if the energy to the exhaust now known as waste is held at a low figure.

It is possible to design a heat exchanger that is highly efficient if the designer elects to ignore the bulk, but since station floor space is at such a cost premium, the current design scheme is not the most desirable. Compactness should be the keynote of future designs.

Encouraging progress in heat-exchanger size reduction appears to be under way in Europe where rotary-type multidisks have passed through their experimental stage with good results. As an example of the comparative performance, dimensions and weight of the rotary-type heat exchanger versus the shell-and-tube unit, note the following for a specific service:

	Rotary type	Shell-and-tube unit
Air mass flow (lb./sec.)	100	100
Thermal ratio	0.80	0.75
Gas pressure drop (psi.)	0.70	0.50
Weight (lb.)	5,500	37,000
Number of disks	10	....
Disk diameter (ft.)	4	....
Dimensions (ft.)	12x8x6	16x16x5

An internal-combustion turbine, and for that matter, any turbine follows the process of a sustained energy supply as differentiated from the reciprocating-engine arrangement.

The mathematics, dynamics, thermodynamics, compression and expansion, fundamental cycles, reheats, entropy, enthalpy, and fuel compositions for internal-combustion turbines are too tedious and detailed to discuss here; nevertheless, the day of the gas turbine is close at hand. The speed at which it will prove possible to establish it as a serious competitor to existing rivals will in the final analysis depend on the cost of the unit and the building to house it.

For many years its production costs will have to carry the development and research changes that have gone into its improvements since inception; this will be particularly true of small units rated 1,500 hp. and below where thermal efficiencies are now painfully low.

Some Blind Trails

To illustrate mathematically some of the blind trails the pioneer experimenters followed early in the century, a fundamental equation was developed for the perfect cycle in which:

Maximum thermal efficiency

$$\frac{W_n}{H} = \frac{C_p\,[(T_t - T_c)\,(1 - [P_a/P_c]^{(K-1)/K})]}{C_p\,(T_t - T_c)}$$

$$= 1 - (P_a/P_c)^{(K-1)/K}$$

where

W_e = network.
C_p = specific heat for medium.
T_c = temperature of compression.
P_c = compression pressure abs.
H = heat absorbed per pound
$= C_p (T_f - T_c)$
T_f = firing temperature.
P_a = atmospheric pressure abs.
$K = C_p/C_v = 1.4$.

The above theoretical result excited analysts early in the century because it is indicated that the efficiency of a gas turbine was independent of the temperature and strictly a function of the pressure ratio.

The experimental models of Armengaud and Stodola quickly dispelled these conclusions when thermal efficiencies of less than 1 per cent were realized. A reexamination of the problem showed that had the analysis been pursued in an orderly progressive manner which gave cognizance to the losses as they occurred, the end result would have been close to the actual model experience.

To illustrate, assume the temperature in the combustion chamber T_f to be four times the temperature T_c at the end of compression, then the theoretical work of expansion $W_e = C_p T_f [1 - (T_e/TF)]$ would be four times the work of compression $W_c = C_p T_c [1 - (T_a/T_c)]$. The margin in this theoretical instance would be 0.75 W_e. If the compressor and turbine are assumed a 50 per cent efficiency, the actual compression work would be $W_c/0.50 = 2W_c$, while the actual available turbine work would be $0.5W_e = 0.5 \times 4W_c = 2W_c$. The actual net work would be $2W_c - 2W_c = 0$.

As indicated, it is highly misleading to accept the results of theoretical derivations for ideal conditions and finally make allowances for imperfections without seeing clearly the manner in which they are involved in the calculations.

A family of curves denoting the thermal efficiency as a definite function of the maximum temperature is shown on Fig. 1.

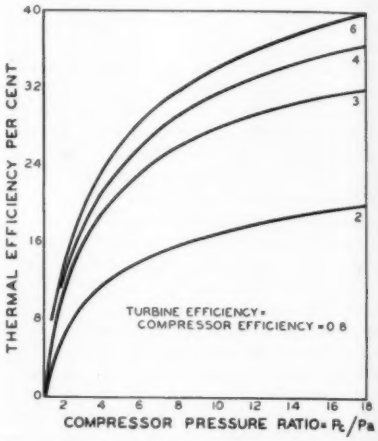


Fig. 1—Thermal efficiency for various maximum temperatures.

As further proof of the effect of temperature let $W_e/W_c = T_f/T_c = 4$ in the first instance and 6 in the second, with turbine and compressor efficiencies of 70 per cent:

$T_f/T_c = 4$ with a compression ratio $P_c/P_a = 4$.

$(T_e/T_a)^{0.286} = 4^{0.286} = 1.487$.

$$W_c = C_p T_c \left(1 - \frac{1}{1.487}\right) = 0.328\, C_p T_c.$$

$W_e = 4 \times 0.328\, C_p T_c = 1.312\, C_p T_c$.

Net work $= C_p T_c (0.7 \times 1.312 - 0.328/0.7) = 0.449\, C_p T_c$.

Heat added $= C_p (T_f - T_c) = C_p T_c [(T_f/T_c) - 1] = 3\, C_p T_c$.

$$\text{Thermal efficiency} = \frac{0.449\, C_p T_c}{3\, C_p T_c}$$

$= 0.15 = 15$ per cent.

Raising the T_f/T_c ratio $= 6$ with a compression ratio $P_c/P_a = 4$

$(T_e/T_a)^{0.286} = 4^{0.286} = 1.487$.

$$W_c = C_p T_c \left(1 - \frac{1}{1.487}\right) = 0.328\, C_p T_c$$

$W_e = 6 \times 0.328\, C_p T_c = 1.968\, C_p T_c$

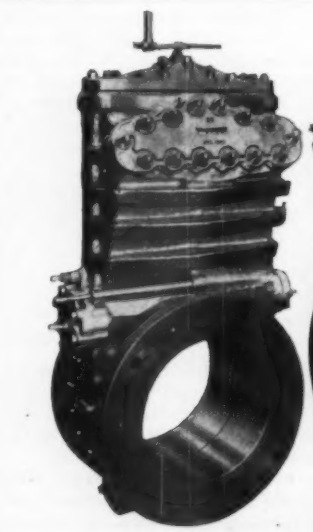
Net work $C_p T_c (0.7 \times 1.968 - 0.328/0.7) = 0.9096$.

Heat added $C_p (T_f - T_c) = C_p T_c (T_f/T_c) - 1 = 5\, C_p T_c$.

$$\text{Thermal efficiency} = \frac{0.9096\, C_p T_c}{5\, C_p T_c}$$

$= 0.1819$ or 18.19 per cent.

The increase in thermal efficiency



COMMERCIAL ORIFICE FITTINGS for Large Transmission Lines

TYPE CN ORIFICE FITTINGS. Above are three 20"—300 Lb. ASA "Commercial" Type CN Orifice Fittings ready for installation at the delivery end of the Texas-California gas transmission line. Type CN Orifice Fittings are available in sizes 2" to 20"—125 Lb. to 2500 Lb. ASA. Other types to 30"—125 Lb. to 600 Lb. ASA.

TYPE DSB ORIFICE FITTINGS. At left is a 24"—300 Lb. ASA "Commercial" Type DSB (Deadline) Orifice Fitting, recently installed in a large west coast gas line. Other "Commercial" Deadline Orifice Fittings, 2" to 24", 125 Lb. to 2500 Lb. ASA.

SEND FOR NEW CATALOG and refer to pages 1254 to 1271 in 1950 COMPOSITE CATALOG.

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18.19 per cent — 15 per cent = 3.19 per cent is a direct result of the increase in temperature ratio.

To summarize the extent to which the gas turbine will replace its electric and reciprocating competitors depends on economics as dictated by thermal efficiencies. Where fuel is cheap and economic studies indicate a relatively short period in which to return the investment, then the simple cycle turbine with low thermal efficiency should be the unit to choose; however, the high-speed diesel engine or cheap electric power may be serious competition for this type of unit. It will have the advantage of large power in small bulk and may easily undersell the diesel engine in powers above 1,500 hp. Also, the facility to operate it through a reasonable range of speed should give it a definite advantage over electric motors when load conditions shift above or below normal.

On the other hand, for long-term service with higher investment, the thermal efficiency of the gas turbine may be appreciably increased by the use of heat exchangers, reheaters, and intercoolers. For most applications, there is an economic compromise between these two objectives. If higher efficiency is the watchword, then a higher price must be paid to house the bulk and weight of the additional equipment. For the simple cycle without heat exchange, a low-cost plan should result.

Currently, turbine units of the internal and external combustion cycle are under construction and one may find protagonists of either scheme prepared to argue powerfully for their respective merits. No general rule can be used to determine the advantages of one system over the other; economics usually will be the deciding factor.

The greatest impact of the gas turbine should make itself felt in the gas-transportation field. The massive reciprocating units used as standard today together with their cumbersome foundations and the ever-present bugbear of vibratory periods will not be a problem when gas-turbine-powered centrifugal or coaxial-flow compressors are efficient competitors. There should be sufficient power and compressor capacity in such a unit to cut space requirements to 40 per cent of that needed by standard equipment today. In addition, no prime-mover cooling water and very little lubricating oil will be needed to satisfy the machine's demands. Maintenance should be definitely less than with present equipment and with experience reliability should equal, or be greater than, reciprocating equipment.

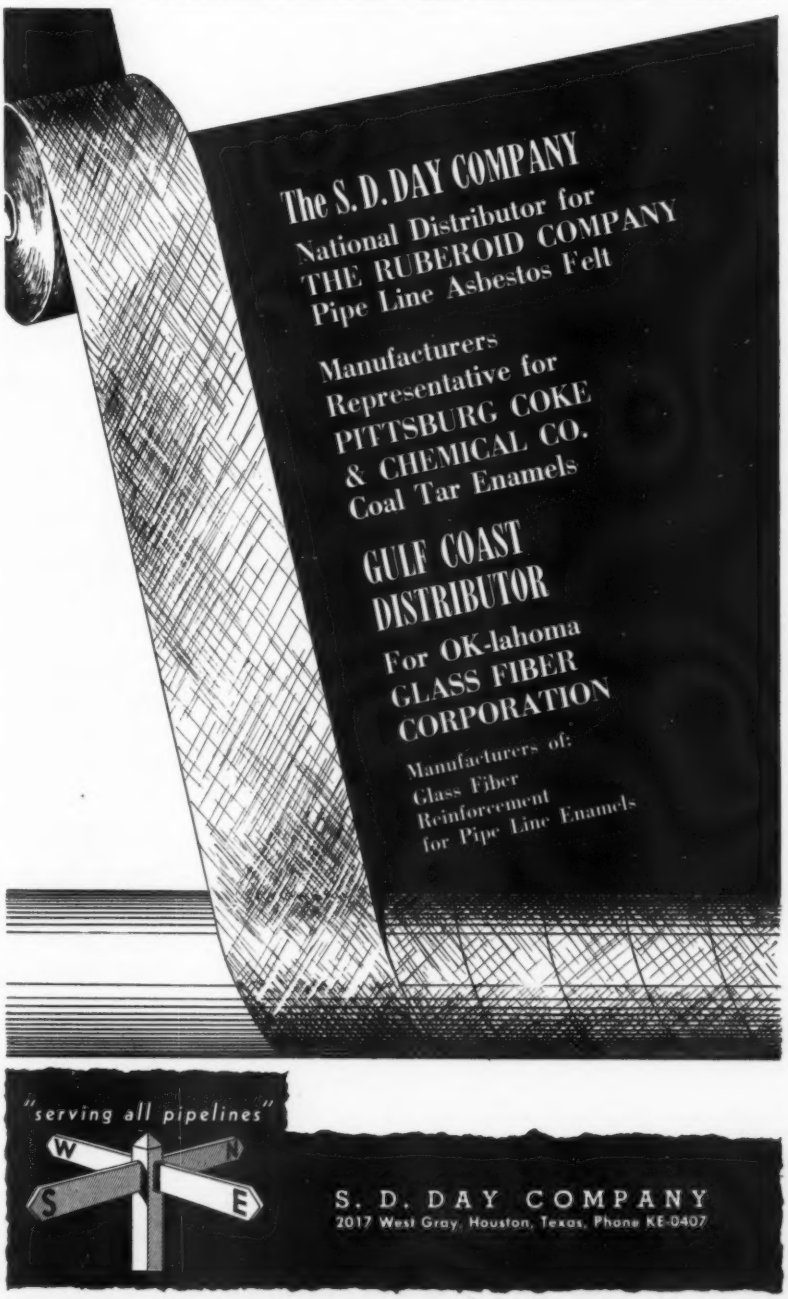
The one outstanding feature should be the assurance of building just one machine to handle the maximum capacity of the largest gas trunk transportation pipe line and the discharged volume to such a system will be at sustained rather than pulsating pressure.

Similar advantages will be available to liquid pipe lines, although of necessity, the power units will be smaller and, hence, less efficient.

It should prove interesting to observe the problems and operational difficulties that unfold in the pipeline systems that initially standardize on gas-turbine power. To offset these should come latent benefits that may not be apparent in the first analysis.

Pipe-Line Lingo

"Pay-day Whitey" is a foreman who got his nickname by letting his crew quit early so he could be first in the pay line. "Deep Water Jim" could wade through water where others had to walk around it; "Tangle-eye Ti" was cross-eyed and titanic. Other descriptive nicknames are: "Bow-tie Blackie," "Society Red," "Little Bam" (from Alabama), "Three Day Red," "Middle of the Road Red," "Owl Face," "Race Horse," "Copenhagen Bill," "Main Line," "Spark Plug," "Lazy," "Coon Dog," "Pop-off Red," "Griping Tony," "Bell Hole Slim," "Bushy Creek Hampton," "Cold Blood," "Squirrel," "Angle Iron" and "Flat Rock."



XUM

How Gulf Pipe Line Locates

'Hot Spots' on Crude-Oil Lines

Corrosion mitigation boils down to economically locating 15 per cent of bad pipe without uncovering. Here's the method one company finds successful

by M. C. Callahan

IN May and June of this year a Mid-Continent pipe-line company lifted and salvaged 72.21 miles of bare 6-in. pipe. All of the pipe was located in northern Oklahoma and southern Kansas. Of the total of 72.21 miles, 10.96 miles or 15 per cent was found to be corroded sufficiently to be classified as junk and of no further use as pressure line pipe. The section of pipe salvaged was laid in 1917. This experience is an indication that few pipe lines, under average soil and terrain conditions and from external corrosion, ever enter the total junk classification. The terrain in the area is typical of most encountered in the midwestern states. The 61.25 miles of good pipe is being used in other areas. Knowing these facts and attempting to control the corrosive action on this average percentage of corrosive areas is the purpose of a pipe-line cathodic-protection program.

The principal problem in corrosion mitigation is locating this 15 per cent or less of bad pipe which we normally call "hot spots" because of their sometimes wide separations. The cost to uncover and lift a pipe line to inspect and locate these so-called hot spots is prohibitive, therefore it becomes necessary to devise methods of locating the hot spots by means of electrical measurements.

M. C. Callahan is superintendent of the telephone and telegraph department of the Tulsa pipe-line division of Gulf Refining Co. He joined the electrical and communications department of Gulf Pipe Line Co. in 1928. He was located in the Seminole, Okla., district until 1931 when he was transferred to the Missouri district at Springfield. In 1936 he was transferred to the New Mexico district at Hobbs, and to Tulsa in 1940. He was named to his present position in 1942.

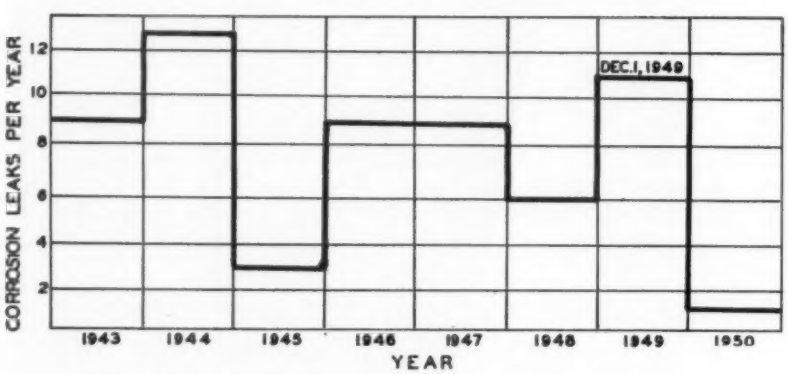


Fig. 1—Plot of leak rate on 4.4 miles, three 8-in. bare pipe lines.

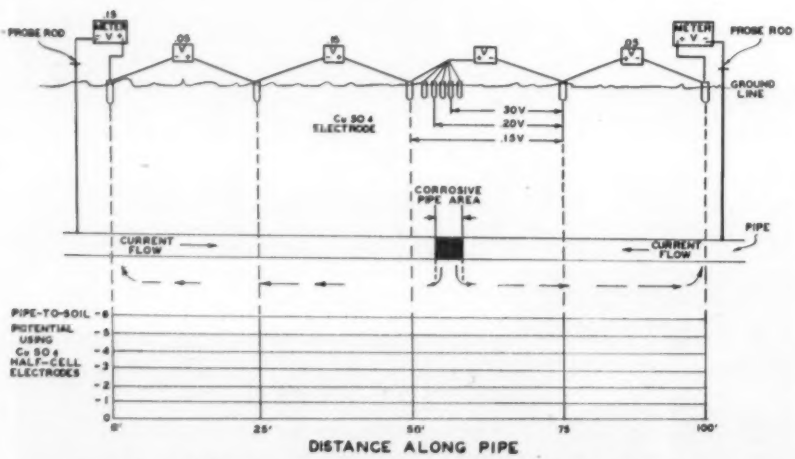


Fig. 2—Schematic arrangement of surface-potential test section.

PIPE-LINE Section

Several methods of locating corrosive areas are used by those companies concerned with the control of pipe corrosion. The pipe-to-soil-potential method is used frequently. Disadvantages of this type of measurement are that at each reading made a probe bar has to be inserted into the earth and pipe postively contacted. This leads to the problem of locating the pipe with finding devices and prodding until pipe is contacted which is a time consuming task even at 100-ft. test spacings.

Soil-resistivity measuring devices also are used in conjunction with pipe-to-soil potentials as a proof check of corrosive hot spots. Low-resistivity soil is used as the criterion for corrosive sections of pipe. This method is fast and saves survey time but is more costly in anode investment because the anodic point of cor-

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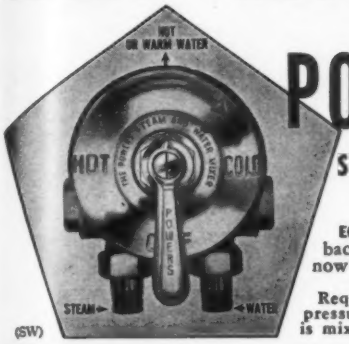

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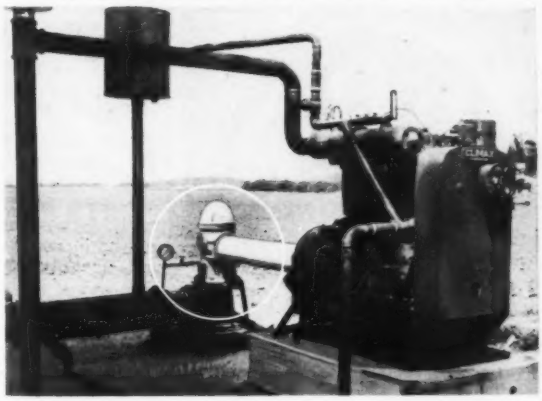

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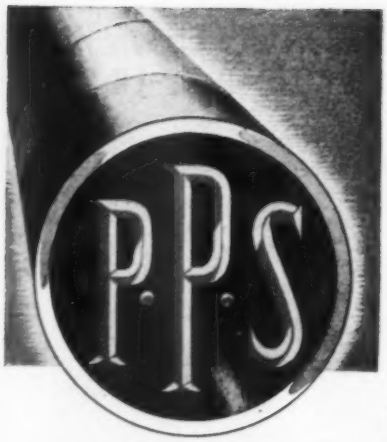

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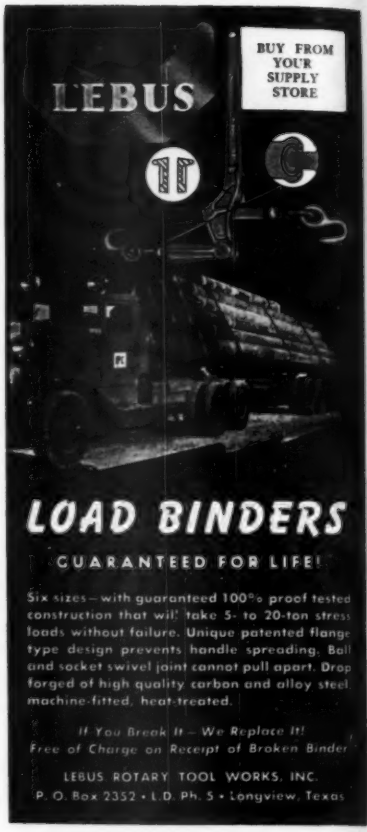
rosive areas are not accurately located. From observation it seems that in the recent past that too much emphasis has been placed on the cost of anode installed instead of why and where installed. An economic study of cathodic protection projects should show cost per mile for protection and degree of protection to be obtained.

Old leak reports are the criteria for initial cathodic - protection projects. Such records indicate the most corrosive sections which are usually well defined and magnesium anodes are planted at these spots. As an example, take the case of a 4.4-mile section of three bare 8-in. lines in parallel laid in 1907, 1915, and 1923. The pipe was protected with magnesium anodes in this manner. Fig. 1 shows results obtained. However, in trying this practice on newer systems the results proved less effective. Because leak reference on newer lines was not absolute in defining the corrosive areas, a need was felt for a more conclusive method of survey which would pin-point the hot spot. Surveying for pin-point location of corrosive spots is time consuming, but for each magnesium anode eliminated a sufficient saving is realized to more than offset the cost of the increased survey time. This survey system is referred to as the surface-potential method.

Determining Surface Potentials

Surface potentials are determined by the voltage difference between any two sections of soil with readings obtained by use of multirange voltmeter-potentiometers, $CuSO_4$ half cells and other miscellaneous equipment. Since the materials in underground pipe structures are relatively the same, the most positive soil areas directly over the pipe represent the most negative pipe-to-soil potentials. Voltage gradients near the corrosive spot will be steep; therefore, in the final analysis the distance between electrodes in the soil over the pipe may be reduced to 1 ft. to locate the exact location where current is leaving the pipe.

An occasional direct pipe-to-soil-potential reading is made by contacting the pipe structure. Soil-to-soil voltage is taken with copper sulfate ($CuSO_4$) half cells as contactors. Keeping in mind that the soil is the variable in pipe-to-soil potentials, new pipe-to-soil potentials can be computed (observing polarity) by addition of the successive soil-to-soil voltages. These additional pipe-to-soil readings are obtained without prod contact to the pipe, as shown in Fig. 2. The results indicate a cathodic condition along the entire 100-ft. test area. Initial measurments were taken at 25-ft. spacings until a reversal of current polarity was indicated. At this point, test spacings were decreased to 1-ft. intervals until the meter readings indicated the exact lo-



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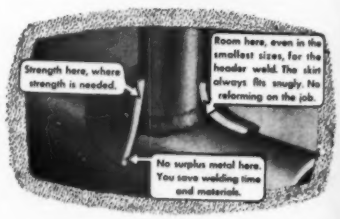
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cation at which the current was leaving the pipe. These tests definitely show the current flow from pipe to soil at the peaks or anodic spots.

The area in which Fig. 2 test was made covered a distance of 1.69 miles or 8,863 ft. Based on the theoretical assumption that the dividing line for the placement of anodes is in soil of 5,000-ohm resistance or lower, the requirements for this section of 1.69 miles of bare pipe line totaled 137 anodes. Through surface potential-survey location of anodic spots we feel that this section has maximum protection with the installation of 39 magnesium anodes of different sizes and weights. Thus we can accurately locate many more leak areas and are able to stop corrosion with a minimum number of anodes. Maximum test spacing for surface-potential surveys of known or suspected leak areas is considered to be 25 ft.

As was mentioned heretofore, the surface-potential system of survey is time consuming; however, the increased engineering-survey costs are offset by the decreased amount of magnesium required and more leak areas are accurately located thus making this system the most desirable survey method to date.

Many meters are available that are suitable for surface potential surveys. They fall into two classifications:

1. High-resistance voltmeters.

2. Potentiometers.

High-resistance voltmeters should be zero centering, 100,000 ohms per volt or higher with full scale reading of: .025/.050/.1/.2/1/5/10 volts.

Potentiometers should have .050/-500/1/2/10 volt full-scale reading. Either type meter used should be as rugged as possible, light weight, and require no leveling. Either instrument is suitable. Conditions under which they are used would be the basis for selection of type.

In making the potential drop tests it is essential that the $CuSO_4$ half cell electrodes be balanced. This is done by placing the wood plugs of each cell together and measuring the potential difference between them. A zero reading is required for accuracy. If any differential is noted they should be cleaned and repaired.

It is suggested that any attempt to experiment with the surface-potential analysis be carried on at the site of a number of definitely known leak areas.

Pipe-Line Lingo

The spread superintendent in addition to being called spreadman may be also a "stroke," "bulling power," or "heavy." The timekeeper is a "number grabber"; the paymaster or office worker who writes the checks is the "chink that spreads the ink."

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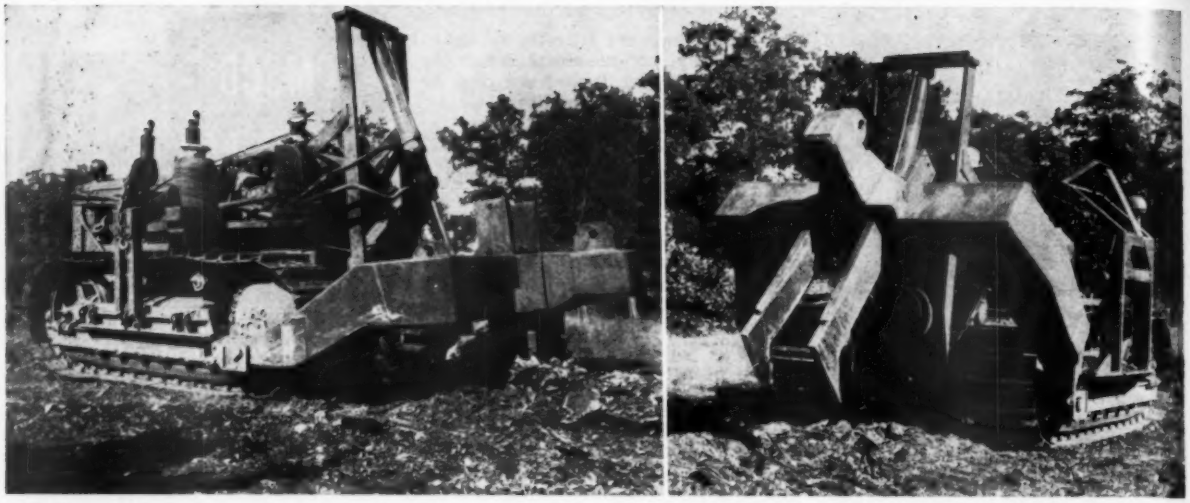

Left: The giant rooter is working here on the ditch for a line in Lone Star Gas Co.'s Hill Country system in south-central Texas. In this operation two rooter blades are being used, rather than the single blade most often employed. The semicircular pieces on the rear portion of the rooter mark other positions in which rooter blades may be used. Right: The rooter is shown here in a raised position. The dark rectangles in the crossbar and in the bumper portion of the rooter show other possible positions for the rooter blades. The bumper makes it possible to add the push of a bulldozer to the power of the crawler tractor on which the rooter is mounted.

THE PLOW THAT PAYS

by H. B. Dempsey*

PIPE-LINE Section

AS all pipe-line construction men know, the making of ditch is considered one of the principal phases of building any underground pipe line. With the difficulty of cutting ditch in mind, pipe-line surveys have been routed over longer distances in certain terrains in order to traverse country more suitable to ditching operations. Of course, the expense in making the ditch in undesirable terrain and the cost of additional labor and material over the longer route, are always weighed together and the less expensive job usually is chosen.

Due to our recent shortages of steel and the necessity of reaching certain areas through extremely rugged country, our company pipe-line officials and technicians began looking for means whereby they could construct pipe lines along a more nearly direct line without so much ditching expense. The fruit of this search was harvested in the use of a "rooter-type plow" fixed to a crawler tractor and controlled by hydraulic power.

The plow.—This attachment consists of a heavy steel beam attached to the back hub on either side of the tractor, and to the drawbar. The beam has adjustable slots for fitting the specially built rooters in a vertical position. The rooters are stationary to the beam but the beam is raised or lowered as desired by means of a hydraulic jack operated by the tractor driver.

The rooters are made of 2½-in. plate steel 10 in. wide, and 6 ft. 6 in. long. The front part of the rooter is trimmed to form a cutting edge while the "foot" or bottom part of the rooter is cut to a point on a 16-in. width, to withstand the pressure built up in plowing rock or tight sandy soil. The extended point aids in breaking up the rocks or soil and in forcing the plow into the ground. Two rooters are used spaced the width of the desired ditch. This is to loosen the soil so that the ditcher only has to handle the loose soil or crumbled rock.

*District foreman, Lone Star Gas Co., Ranger, Tex.

Results

A close survey was made of the initial operation of the plow on a project then in progress. As usual, in this type country where layers of limestone rock were most frequent just beneath the topsoil, the ditch was the most expensive part of the project.

Before.—Prior to the use of the plow, a ditching machine was used to strip the topsoil from the ditchline. Then a crew of men with air compressors and shooting equipment blasted the rock ahead of another ditching machine, before a completed ditch could be effected. This method not only required a number of men, considerable powder and equipment for the successful completion of the ditch, but it also had a dilatory effect on the remainder of the job.

After.—When the plow was put to work on the ditchline ahead of the first ditching machine, it was found that a completed ditch could be made by a single pass with one ditching machine, except for places where limestone boulders were too large for the plow to move. The plow usually crumbled the limestone so that it could be removed from the ditch with the ditcher. In some cases rock boulders too thick to crumble were plowed out of the ground and pushed aside with a dozer blade.

Records of the first tests showed that shooting of the ditchline had been reduced 83 per cent, thereby reducing the expense of the ditch 46 per cent by use of the plow ahead of the ditching machines. We also found that in some types of tight soil, our ditching machines could make 40 per cent more ditch on the plowed ditchline.

Other Uses

We have found advantages in using the plow for the removal of pipe lines as well as for making pipe-line ditch. A 15-mile 6-in. screw pipe line was removed simply by plowing with these rooters. The dirt was loosened along on either side of the pipe with the rooter plow. After this was done, a "sliding shoe" was pulled under the pipe line to break it loose from the soil directly underneath and then it was cradled out of the dirt which fell off the pipe onto the ditchline. This eliminated the necessity for backfilling operations on the salvage job.

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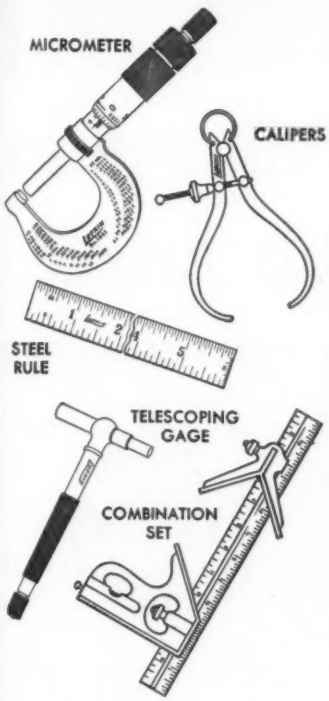

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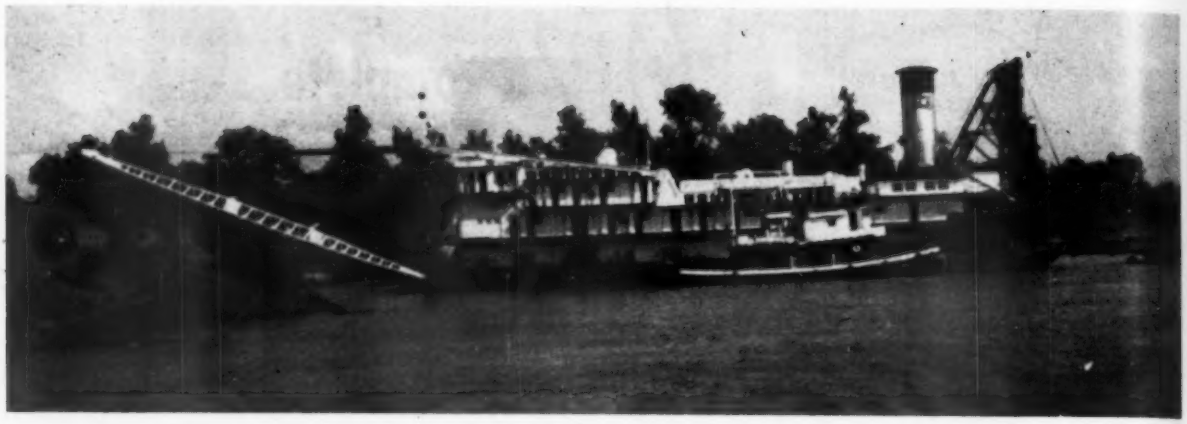
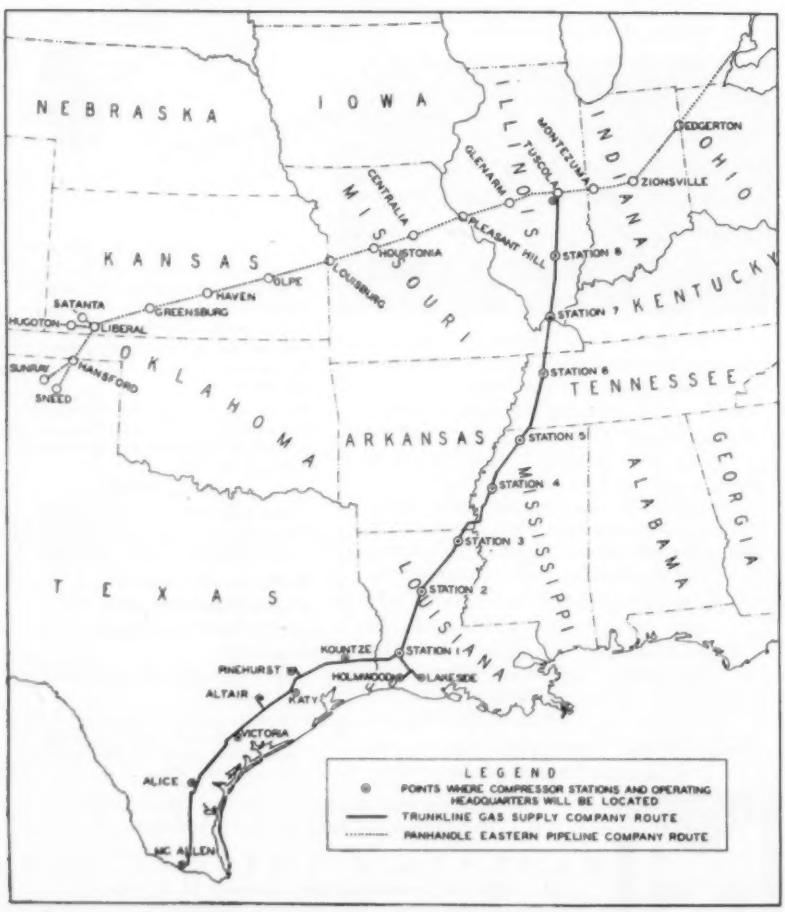


First construction on Trunkline's new gas artery was started in July at the Mississippi River crossing.

Unusual Practices Being Followed in Constructing Trunkline Gas Artery



Map showing route of pipe line under construction for Trunkline Gas Supply Co. from McAllen, Tex., to a connection with the Panhandle Pipe Line Co. system at Tuscola, Ill.

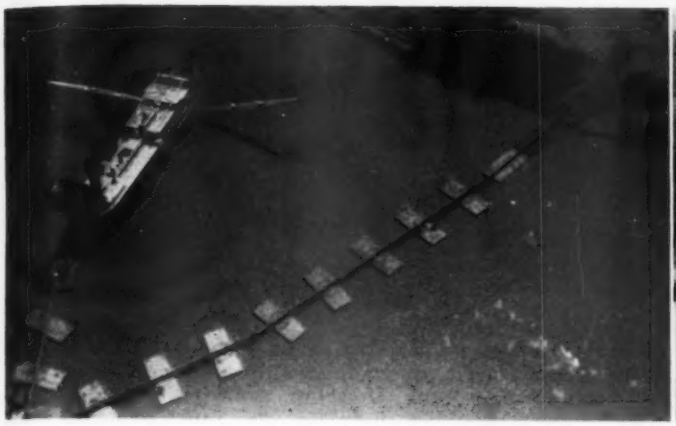
by Leigh S. McCaslin, Jr.
Houston District Editor

PIPE-LINE Section

A NUMBER of new and interesting practices are being followed in the construction of the 1,300-mile gas pipe line of the Trunkline Gas Co. This new gas artery runs from South Texas to Central Illinois where it ties into the Panhandle Eastern Pipe Line Co. system. Panhandle's terminus and major market is the Detroit area.

River crossings.—A reinforced-concrete coating is being used on the pipe for 10 major river crossings. Reinforcing for this pipe consists of ½-in. longitudinal and circumferential rods. In both cases the rods are placed on 8-in. centers. Next, 14-gage wire mesh is wrapped completely around the pipe on top of the grillage formed by the ½-in. rods. Gunite is then applied to a thickness of 2½ in. Barite is added to the Gunite to increase the weight of the coating material.

The special coating adds 275 lb. per lineal foot to the weight of the pipe, giving it an over-all weight in excess of 400 lb. per running ft. There will be approximately 10 miles of this



Left: Pipe is pulled out for the Mississippi River crossing. Contractor on the job is Anderson Bros. Corp. Right: The dredge Caribbean moved over 1,300,000 cu. yd. of earth for this cut on the east bank of the Mississippi River.

concrete encased pipe in Trunkline's system. All river crossings, both major and minor, are constructed of ½-in. wall pipe. This same pipe is also being used for all highway crossings.

Compressor stations.—Four compressor stations are to be installed on the line initially. These stations are of a simplified design. The four 2,000-hp. engines in each station furnish the power for all station utilities with the exception of lighting, in addition to pumping gas. Lighting is handled by small gas engine-generator sets. Engine lubricating oil is to be cooled by the gas going through the transmission line. Company engineers believe that lower initial installation costs and some labor savings will result from this unitized design.

Two-cycle, angle-type compressors are being put in the four stations. Total horsepower for the line will be 32,000 with stations at Longville and Darnell, La.; Senatobia, Miss.; and Joppa, Ill. This horsepower will permit a daily sales capacity of 250,000 M.c.f. By adding four additional compressor stations, the line will be capable of handling 375,000 M.c.f. per day sales.

Pipe.—The line itself is being designed for a 900-psi. operating pressure at the station discharge side. A summary of the total lengths of the various sizes of pipe being used is as follows: 726 miles 26 by ⅜-in.; 217 miles 24 by 9/32-in.; 150 miles 20 by 9/32-in.; 145 miles 20 by ¼-in.; 18 miles 16 by ¼-in.; 16 miles 12¾ by ¼-in.; 11 miles 10¾ by ¼-in.; 16 miles 10 by ¼-in.

Communications.—A microwave radio system will be installed on the new line. Houston, operating headquarters for Trunkline, will be con-

THUMBNAIL HISTORY OF TRUNKLINE GAS CO.

Trunkline has an interesting history. It was originally known as Trunkline Gas Supply Co. and was promoted by Ralph K. Davies of San Francisco, well-known oil figure, and Lewis W. MacNaughton of DeGolyer & MacNaughton, Dallas. The company's first application to the Federal Power Commission was made early in 1947 for a line from the Gulf Coast to Keokuk, Iowa. Later a second application was made and granted to Trunkline which changed the terminus to the Palmyra, Neb., station of Northern Natural Gas Co. However, Northern Natural refused to enter into a written agreement with Trunkline.

After a series of negotiations, Trunkline made an agreement with Panhandle Eastern Pipe Line Co. to build the line to that concern's Tuscola compressor station in eastern Illinois. In the transaction Panhandle acquired 60 per cent of the outstanding stock of Trunkline. Trunkline signed a 20-year contract with Panhandle to supply 250,000,000 cu. ft. of gas daily. Only other customer of the company is the gas-distribution company at Metropolis, Ill., which will receive approximately 1,000,000 cu. ft. daily.

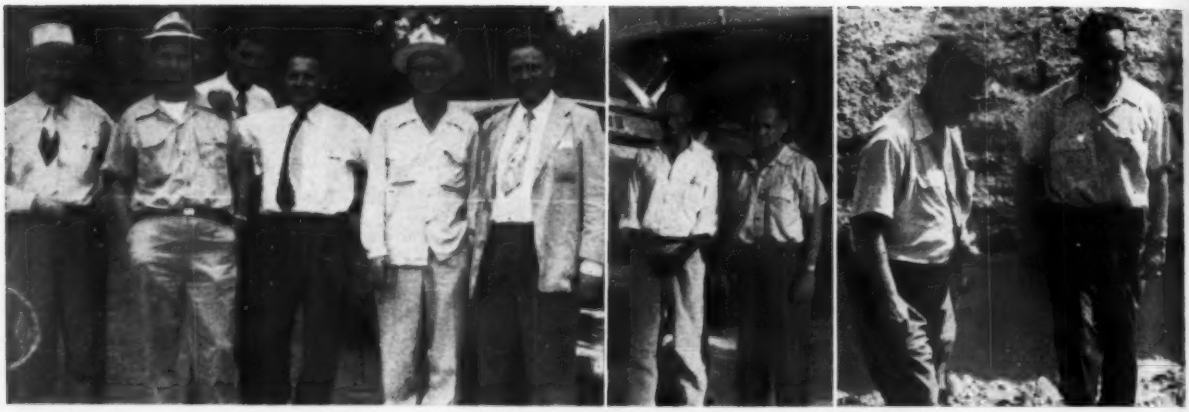
Natural-gas reserves contracted for supplying the line have been estimated to be 2,000,000,000,000 cu. ft. Gulf Coast fields to be connected with the proposed system include Lakeside and Holmwood in Louisiana; and Pinehurst, Altair, Columbus, Ramsay, and McAllen, all in Texas.

As regards financing, the concern has sold $14,000,000 worth of common and $6,500,000 worth of preferred stock. This stock is 60 per cent owned by Panhandle and 40 per cent by Trunkline's original promoters. Just recently Trunkline floated a $60,000,000 issue of 20-year, first-mortgage, 3¼ per cent bonds. These were purchased by 10 insurance companies with Metropolitan Life Insurance Co. being the prinicpal concern.

Officers of Trunkline are: W. G. Maguire, chairman of the board; Hy Byrd, president; E. Buddrus, vice president; W. K. Sanders, vice president; S. A. Taylor, vice president and treasurer; Lewis W. MacNaughton, vice president; F. S. Young, chief engineer; and Leith V. Watkins, secretary. Directors of the company are: Maguire, Byrd, Buddrus, MacNaughton, Ralph K. Davies, Charles E. Main, J. Donald Duncan and Sidney Lanier.

Crewmen prepare Anderson Bros. Corp. pipe laying barge at the Mississippi River location.

XUM



Left: Inspecting an Illinois spread are: L. S. Bayer, E. M. Null, E. E. Dunnsworth, F. S. Young, Harold Finnerty, and Hy Byrd. All are with Trunkline except Finnerty who is a Mahoney Contracting Co. man. Center: Sherman Buell and F. S. Young of Trunkline's engineering staff prepare to take off for an inspection trip. Right: Hy Byrd, president of Trunkline, and F. S. Young, chief engineer, inspect initial construction on the firm's 1,300-mile Texas to Illinois gas line.

nected to all stations. The Trunkline organization has handled all planning, designing, purchasing, and supervision on the line rather than follow the more common procedure of hiring outside firms. At present, Trunkline has a force of over 200 men in the field. Officials of the company are well pleased with this all-company procedure for building the line. Work has proceeded at a smooth, rapid pace.

Surveying and mapping for the system began on June 1 of this year and had been completed by early August. A total of 1,250 miles were surveyed and mapped. Over 20 survey crews were kept in the field to accomplish the job. Aerial photographs were taken over the entire right-of-way for determining the preliminary routing of the line. Aero Exploration Co. of Tulsa handled the photographic work.

The company is proud of the unusually level right-of-way which it obtained for the line. The route follows the Mississippi River Valley, from the Gulf Coast some distance into Illinois with only a few hundred feet change in elevation. In addition, there are very few rocky areas to contend with during construction.

In one of the largest and fastest contract lettings in pipe-line history, Trunkline awarded $15,500,000 worth of pipe laying towards the end of June. The bids came in at noon one day and all contracts had been signed by noon of the next day. Contracts were awarded as follows:

Section A: 176 miles of 26-in., from Longville to Darnell, La., Houston Contracting Co.

Section I: 33 miles of 20-in., 18 miles of 16-in., and 8 miles of 10-in.,

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PIPE LINE SURVEYS

from Longville, La., south, Houston Contracting Co.

Section B: 180 miles of 26-in., from Darnell, La., to Senatobia, Miss., Anderson Brothers Corp.

Sections G and H: 217 miles of 24-in., from Longville, La., to Altair, Tex., Anderson Brothers Corp.

Section C: 184 miles of 26-in., from Senatobia, Miss., to Joppa, Ill., R. H. Fulton & Co.

Sections E and F: 262 miles of 20-in., from McAllen to Altair, Tex., R. H. Fulton & Co.

Section D: 186 miles of 26-in., from Joppa to Tuscola, Ill., Mahoney Contracting Co.

Separate contracts were let for four major river crossings under the Ohio, Mississippi, Washita, and Red rivers. Anderson Brothers Corp. has the contract for the Mississippi crossing and J. Ray McDermott & Co., Inc., has the other three. Six river-crossing contracts remain to be let. All crossings are to be underneath the river with no overhead lines planned.

Multiple lines are being laid under the 10 major rivers. X-ray inspection is being made of all joints at river crossings and of 25 per cent of the line welds. X-Ray Engineering Co., San Francisco, has the contract for this work.

A marine depth-recording device is being used to determine river-bottom profiles at major crossings. It is also being used to determine the location of the pipe after it is laid. Swift currents and deep water made accurate soundings impossible using ordinary sounding methods.

First construction on the new line was begun in July at the Mississippi River crossing. Pipe laying was started shortly thereafter in Louisiana and Illinois by Mahoney Contracting Co. and Houston Contracting Co. Compressor station bids will be received during September and it is planned to have construction under way by approximately October 1.

Trunkline anticipates that it will be able to push the line to completion despite possible shortages and higher prices brought about by the Korean War. Construction contract are on a "turnkey" basis, hence the company will not be handicapped by escalator clauses. All major equipment items have been purchased. Ninety per cent of all compressor-station equipment has been bought. Pipe is rolling out of Kaiser Steel Corp.'s California mill at a rapid rate. By mid-August, 150 miles of the 730 miles of 26-in. pipe in the line had been delivered.

Since Trunkline's gas will be flowing into the war-vital Detroit area, company officials feel sure that the Government will consider the project essential, regardless of world conditions. Estimated date for completion of the main line and the Louisiana lateral in August 1951. Scheduled completion date for the entire line is October 1951.

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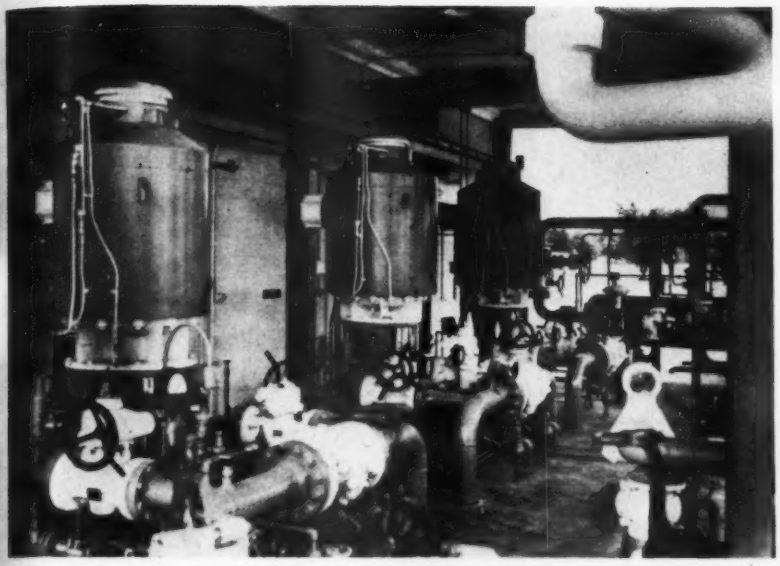


Fig. 1—View of vertical centrifugal pumps, Boise station, Salt Lake Pipe Line Co.

Pump-Station Operation

on Salt Lake's product line

by John P. Newton, Jr.*

PIPE-LINE Section

OPERATION of the Boise pump station of Salt Lake Pipe Line Co. will be of special interest to pipe liners. Pumps installed at Boise station are different from any other pump station of the line. They are vertical centrifugal with electric drives, whereas all others on the company's crude and products lines are diesel-engine drive with positive-displacement pumps.

*Salt Lake Pipe Line Co., Salt Lake City.

Several considerations prompted the choice of the centrifugal-type pump and the electric-motor drive. Some of the more important reasons follow:

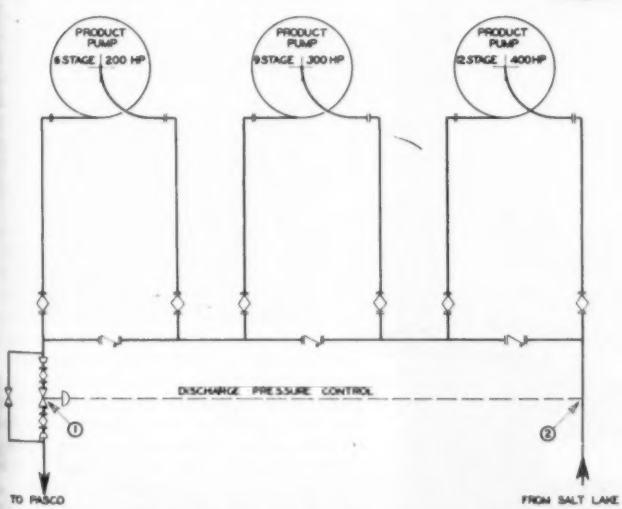
1. The favorable power rate in the Boise area showed a definite saving in using electric power over diesel-engine drivers.
2. The centrifugal-type pumps required only a simple foundation.
3. The floor space required by the vertical centrifugal pumps is less for all three pumps than that required for one diesel-engine driver and pump.

These factors, plus reduced maintenance and simplified operation pointed a definite savings for the installation of vertical centrifugal pumps and electric-motor drives.

Three Pumps at Boise Station

The three pumps at the Boise pump station are United VMS series featuring a vertical double-case design having a simple cylindrical outer barrel, enclosing a volute-type pumping assembly. This type of construction assures high efficiencies, mechanical simplicity, and safe operation. Type VMS pumps are designed for medium capacities, high pressures, and high speeds. Pump discharge is controlled through pump suction.

The Boise pumps are 6, 9, and 12 stage with motor drives of 200, 300, and 400 hp. at 3,600 r.p.m. These pumps were designed to operate in series or any combination thereof. From Fig. 1 it can be seen that to meet any varying capacity and discharge pressure requirements the pumps can be used in seven individual or combination capacities, offering the choice of 6, 9, 12, 15, 18, 21, or 27 stages. Flexibility is thus attained at peak efficiencies of the pumps with a minimum of throttling.



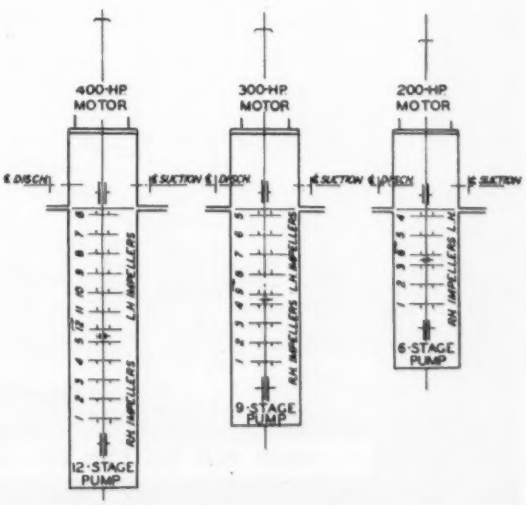


Fig. 2—(Left) Boise pump schematic. At point (1) the discharge pressure controller receives the impulse from the suction side of the pumps. At point (2) the discharge pressure controller valve controls the suction before the pumps by throttling the discharge line after the pumps. This maintains the back pressure in the line before the Boise Station. Fig. 3—(Right) Arrangement for 6, 9, and 12-stage pumps.

This feature is of considerable importance where constant-speed drivers are used.

The radial and thrust loads that are developed by the pumps are carried by the motor bearings. The lower bearing in the motor carries radial loads and the upper bearing in the motor is designed to carry both radial and thrust loads. The motors for Boise pump station were specially built by Allis-Chalmers and differ from horizontal explosionproof motors of equivalent rating principally in the bearings, which are ball bearings designed to take high thrust loads. Motor bearings are designed for a maximum up and down thrust of 3,000 lb. Also the lubrication of the motor bearings is by means of a circulating pump from a reservoir with sight glasses to check both oil flow and level.

Data for Station

The capacity of the Boise pump station is 350 g.p.m. at peak efficiency and a head differential of 5,880 ft. Provision has been made in the design to increase the capacity to 500 g.p.m. at peak efficiency by changing the inner pumping assembly of each pump.

From the above figures can be seen the small amount of floor space taken up by the three pumps and the flexibility of such an installation. In the very near future the final few miles of line between Boise and Pasco, Wash., will have been laid and the Boise pump station will go on the line to deliver products to the Northwest.

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Gas-Compressor Station Design and Construction

(Continued from page 205)

of the failure of one unit, it would then be necessary for the other units in the station to pick up the load of the unit which is down. This can be done by either speeding up the existing units or by increasing the load with clearance pockets.

Due to the high cost of installed horsepower under the present price conditions, there has been a trend toward installing larger-horsepower units with correspondingly fewer square feet of floor space per horsepower hour and fewer units in a station. This will result in a lower installation cost of the compressor station. However, some sacrifice in flexibility of operation will be encountered unless the compressor sizing and the overload capacity of the engine is considered.

Engine characteristics.—The evaluation of known operation and maintenance records on each compressor unit considered should have some bearing on the selection of the unit. It is necessary that the maintenance and operating costs of the units be kept at a minimum to insure economical operation of the station. In regard to predicted operation and maintenance costs of the unit, evaluation of certain engine characteristics is necessary.

Some of the engine characteristics to be considered are the fuel guarantees and fuel consumption (fuel consumption obtained at sea-level rating and at the altitude of the engine location), piston speed, and also fuel gas and lubrication system. It is the opinion of the writer that fuel-consumption guarantee curves should be included in any proposal submitted by the manufacturer.

Cylinder characteristics.—The preceding discussion has outlined the general procedure which is followed in the selection of compressor horsepower. It might be interesting to give several examples of specific items which are looked for and adhered to rather closely. After the initial selection of a particular type unit, there is little that can be specified or changed in the power cycle; however, certain specifications as to the compressor cylinder operating characteristics may be called for. Stations on the main-line transmission system of El Paso Natural Gas Co. are located at approximately 100-mile intervals with a de-

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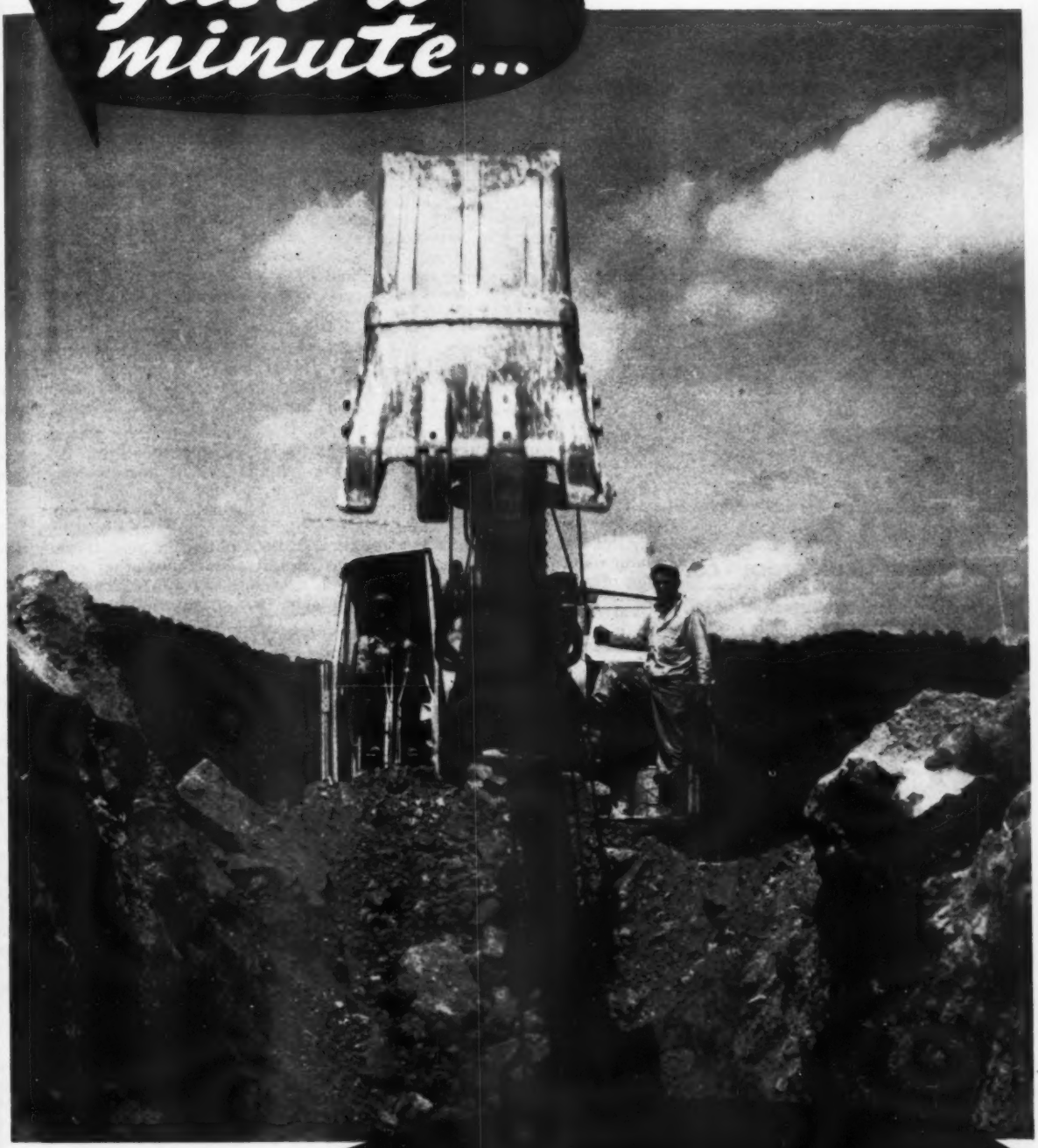

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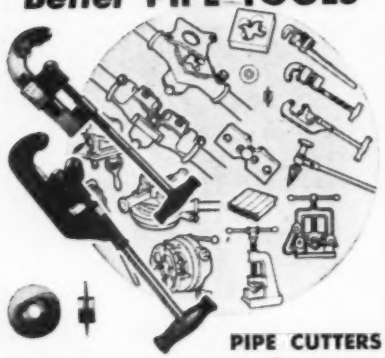

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sign compression ratio of approximately 1.5. However, due to the continuous expansion of pipe-line deliveries, these compressor units must necessarily be designed for operating over a range of compression ratios from 1.25 to 1.8.

For the past several years there has been considerable attention focused on compressors with a large clearance volume and large displacements. This combination levels or flattens out the brake-horsepower curve and allows a loading of the unit over a wide range of ratios without a great deal of unloading capacity. All cylinders, however, are provided with unloading pockets, so that the unit need never be loaded to greater than 5 per cent overload for a full operating period. This should not be construed to contradict the fact, as has been previously mentioned, that the units should be capable of carrying at least 10 per cent overload for short intermittent periods.

Fixed-type pockets are generally used on main-line stations, as it is felt that the variable-type pocket is not necessary except in field stations where the pressure fluctuations are frequent. Field stations having a low suction pressure are very critical in loading, due to the larger horsepower change with a small change in suction pressure.

Valves.—Through a system of reports and records maintained by the operating department, certain design specifications for compressor cylinder valves have become of major importance. It is felt that allowable valve velocities should in no case exceed 3,000 ft. per second. Insofar as the specifications of the valve proper are concerned, the Bakelite-type plate is preferred by El Paso Natural because: (1) Operational reports show this plate to have greater lasting qualities. (2) In case of valve-plate failure, this type does not damage the seat or the valve cage.

El Paso Natural has continually pressed for lower valve velocities in conjunction with increased valve lift, and feels that the lift may be increased, without excessive breakage. Actual horsepower losses which occur in the valves and passages to the cylinder are being more and more closely examined and regulated. A great deal of testing and experimental work has been done in an attempt to determine methods whereby these losses may be reduced even further.

Cylinder jacketing.—Recent station design does not call for compressor cylinder cooling at ratios of compression up to a value of 2.0. It is provided when multistage units with higher compression ratios are installed, but even here there is some question as to whether or not it is necessary or even effective. It is felt that the space allotted to compressor cylinder jacketing by the manufacturer might well be more effectively utilized in streamlining and enlarging the gas passages to the cylinder, thereby reducing the horsepower losses due to valves and passages.

It might be well to mention here that the El Paso Natural feels the economics involved prove cooling of the discharge gas is necessary whenever this temperature exceeds 110° F. This is not only true from a capacity or pipe-line standpoint, but also because of the damage to pipe-line coatings at temperatures in excess of 120° F. Gas coolers are so designed as to cool to 90° F. using an induced-draft-type tower. Cooling-tower sections used are atmospheric sections in a coil shed with tubes of admiralty metal.

Piping Design

All pressure piping is designed in strict accordance with the requirements of the American Standards Association Code, Section 3, which is the section on plant piping. The design of station gas suction and discharge piping is a topic of considerable discourse in the industry. There are numerous bases for the design of gas piping, among them the consideration of gas velocities, the pulsations that are set up by harmonics in gas flow and unit pressure drop. The standard method used by this company to size the gas piping in accordance with definite expected pressure drops through this

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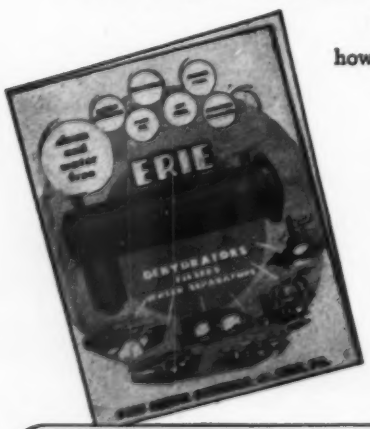

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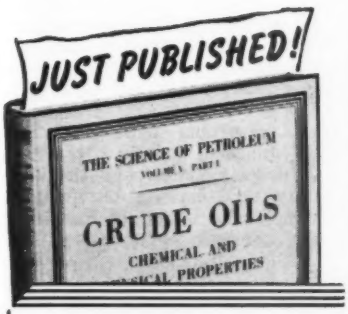

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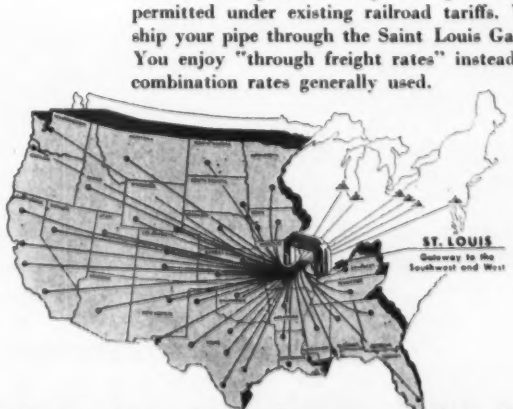

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gas piping is set up on this latter basis.

On outside headers or primary piping a pressure drop of 2.5 psi. per thousand feet is used, while on the leads to the compressor units or the secondary piping, a pressure drop of 1.25 psi. per thousand feet is used as based on Weymouth's flow formula. A large-volume suction header is mounted above the compressor cylinders on each unit. This header is sized by calculating the actual displacement of the compressor cylinder on a per revolution basis and increasing the resultant figure by a factor of 10, which assures low gas velocity and reduces pulsation on the suction side. The compressor lead pipe is projected approximately 6 to 8 in. into the compressor cylinder in order to reduce or eliminate wave action. On the discharge of the compressor units commercial pulsation dampeners are used.

This method of sizing primary and secondary gas piping in conjunction with the proper application of pulsation dampeners and the judicious spacing of pipe supports has proved very successful in reducing pulsating flow and the resultant vibration. A bypass line is installed between the suction and discharge leads to serve as an equalizing line. A relief valve is installed on this equalizing line. A bypass is also installed around the relief valve so that the unit may be vented. Each relief valve on the individual compressor units is vented separately. These vents extend upward to an appropriate height above the eaves of the compressor building so that proper dispersion of gas may be obtained. Valves in the high-pressure gas system are the lubricated plug type having butt-welded ends which tend to reduce installation and maintenance costs.

All pipe 2 in. and above is welded and flanged. Lap-joint flanges are used wherever possible in order to facilitate ease and speed in construction.

The engine-jacket and oil-cooling circulating water circuits are of closed-system design. Sizing of piping for the circulating water systems is based on a pressure drop and velocity principle. The pressure drop and velocity basis used in sizing water systems is 2 ft. of head loss per 100 ft. of run, while the allowable maximum velocity is 6 ft. per second. Engine-jacket water and oil-cooling water are cooled in dry-type air-cooling units. This company pioneered large-scale use of this type of cooling equipment.

Inasmuch as the water supply available at our various plants is very limited, it is mandatory that cooling equipment of a type requiring a very minimum of makeup water should be selected. The inlet temperature of the engine-jacket water into the engines is 150° F. and sufficient circulation is provided to maintain a maximum temperature rise of 10° F. Temperature of the oil-cooling water into the oil coolers is 110° F. with a 15° F. approach to the lubricating-oil temperature. These water temperatures are maintained within very close limits by use of recorder controllers. A diaphragm-operated butterfly valve is installed as a bypass on these two systems at the dry-type cooler units and is operated by the temperature-recorder controller on the instrument board in the compressor building. The motor-driven fans serving one cell of the dry-type cooler are controlled by the temperature-recorder controller. In order to get equal distribution, which will result in maximum efficiency through the dry-type cooling sections, the inlet and outlet water headers are arranged so that a uniflow effect is obtained. The inlet water and fuel gas and starting air headers are in the pipe tunnel of the compressor building, while the return water headers are overhead. All piping, except the general service lines which are hot coated, are placed aboveground on pipe racks or pipe bents.

Associated Equipment

Scrubbers.—All compressor stations are equipped with gas scrubbers on the suction side of the plant. The wet type, or oil-bath-type scrubber, is used on all main-line stations, primarily for the removal of dust, while

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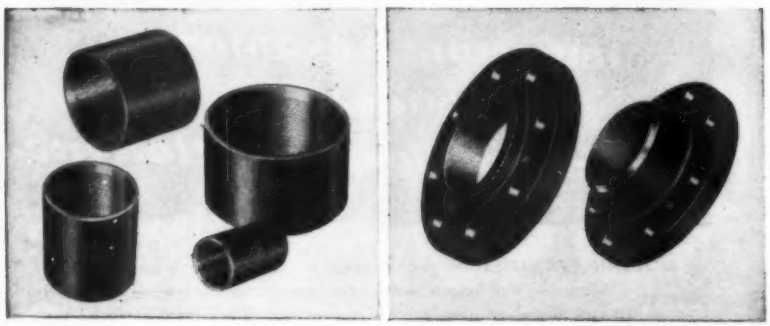

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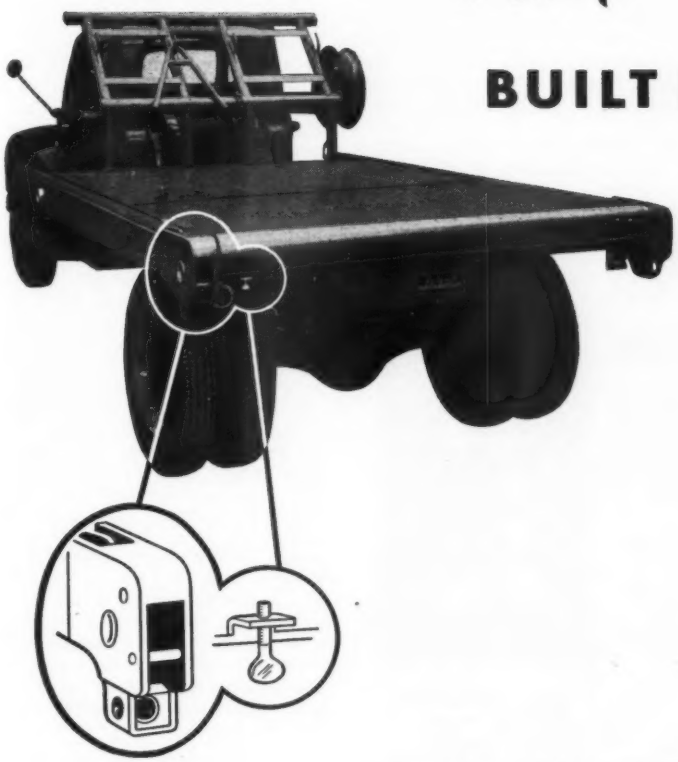

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the dry type is used in the field stations for the removal of liquid entrained in the gas stream.

Cooling equipment. — Inasmuch as water is a critical factor in the operation of compressor stations, cooling-tower installations are held to a minimum. The gas is cooled in induced-draft-type cooling towers from inlet temperatures as high as 250° F. down to 90° F. outlet temperature. The cooling-tower fan is driven by a totally enclosed fan-cooled electric motor. The cooling-tower make-up water is automatically controlled by a float-type valve. Concentration is controlled manually by a recording blowdown meter. Electric-motor-driven vertical turbine pumps located in a pump house are used to circulate the spray water. A spare spray water pump is provided in all cases.

Water pumps.—The pumps used to circulate engine-jacket and oil-cooling water are horizontal centrifugal, electric-motor-driven types, with each system having a spare pump. Surge tanks of ample size and height to eliminate the possibility of introducing oxygen are provided for the jacket-water and oil-cooling water systems ahead of the pump suction. Properly vented return headers are tied directly to the pump suction headers.

Fuel system.—Fuel gas is taken from the suction side of the station and is passed through a heater section where it is heated by water taken from the hot side of the engine-jacket water system. After passing through the fuel-gas heater, the gas is reduced in pressure by a pressure-reducing regulator, then into a surge chamber prior to measurement and further pressure reduction as required.

Lubrication system.—The lubricating oil is stored in 210-bbl. storage tanks and is piped to lube-oil heaters at the compressor and auxiliary buildings, using hot engine-jacket water as the heating medium. The oil is pumped by positive-displacement hand-operated pumps from the lube-oil heaters to lube-oil carts.

Exhaust jackets.—The compressor engine exhaust jackets are insulated and covered with aluminum jacketing to reduce noise as well as to eliminate a considerable amount of heat that would ordinarily be dissipated in the compressor building. The exhaust silencers are of conventional design. The air to the compressor and auxiliary engines is cleaned by oil-bath-type cleaners.

Starting and utility air.—A two-stage motor-driven air compressor discharging into an air receiver at 250 psi. supplies starting air. The standby starting air compressor is driven by an internal-combustion engine. A two-stage utility air compressor, discharging air at 125 psi., is installed to supply air for the utility air system. These two systems are tied together by a pressure-reducing regulator in order to supply air to the utility air system in the event of a failure of the utility air compressor.

Electrical Equipment

Electric power is used for all of the auxiliary equipment associated with the compressor station. The primary and largest use of generative power is for driving the pumps and fans used in the water cooling of the engine compressor units. Other uses include air compressor, water wells, cooling-tower spray-water pumps, lights for the station and employes' houses, and miscellaneous small motors such as are used in the machine shop.

After the cooling requirements for the engine compressor units have been determined, which include the sizing of circulating water pumps, necessary cooling-tower and fin-fan units, total amount of water required, and the necessary lighting required in the buildings, a tabulation can be made of the total electric power needed to run these auxiliaries. After this total power has been computed, allowances are made both for sufficient starting capacity in the generators for the largest motor and in the sizing of the generator unit for the various efficiencies of all of the motor drives.

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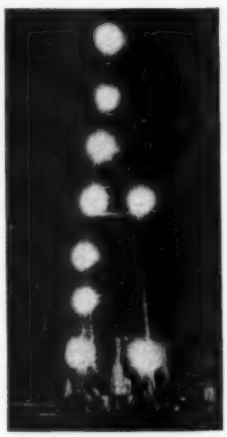

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approximate 0.05 kw. per compressor horsepower. For example, a 10,000-hp. compressor station would require 500 kw. for full-load operation. This 500-kw. load is normally divided between two 250-kw. units with a third 250-kw. generator as a spare.

Distribution.—Electric power is usually generated at 480 volts, 3-phase, 60-cycle. This voltage is used for the primary feeders connecting with the various load centers throughout the station. All of the motors are selected to operate on this voltage. thus eliminating transformers and allowing the use of magnetic starters which are not large and bulky. The majority of the motors are usually 50 hp. or smaller, and the length of primary feeder runs are relatively short; therefore, it is more economical to use 480-volt generation than 2,400-volt or higher.

Transformers.—A three-phase, three-wire system is used and all generators and motors connected delta-delta. Transformers for lighting are delta connected on the high-voltage side and Y connected on the low-voltage side where three-phase transformation is used.

Switch gear.—Drawout-type metal enclosed switch gear with air circuit breakers is used for generator and feeder control. Each generator has its own exciter and voltage regulator, making it an independent unit. These units can readily be parallel through the use of synchronizing equipment.

Generators.—The generator units are powered by gas engines, and the load on these gas engines is controlled by an iscochronous governor such as Pickering 3700 class or Woodward UG8. With this type of governor the frequency can be held fairly constant regardless of changes in load. It is the common practice to set the governors on all of the engines of the same size with the same speed drop, so that no particular engine will have a tendency to take all of the load changes that may occur. These engine generator units are low-speed units in the range of 400 to 450 r.p.m. A belt-driven exciter is used in all cases, this exciter being normally mounted on top of the outboard bearing pedestal.

Totally enclosed fan-cooled exciters are used to eliminate excessive wear of commutator and brushes, since severe sand storms are often encountered. This does not apply to the engine-type generator, since excessive wear of brushes and slip rings has not been experienced.

Motors.—The motors selected for driving pumps and fans are sized so that regardless of load conditions on the driven equipment, the motor horsepower will not be exceeded more than 1 to 2 per cent. In the majority of cases, the required motor horsepower is kept within 95 per cent of full load required by the driven equipment.

Induction motors (440-volt, three-phase) are used at speeds of 1,200, 1,800, and 3,600 r.p.m. Normally an open-type, dripproof motor is used rather than a totally enclosed fan-cooled motor, the motor-driven equipment being located 75 to 100 ft. away from the compressor building which is considered a hazardous area. The control of these motors is a combination magnetic line-starter type, employing air circuit breakers for circuit protection and bimetallic overload relays for overload protection.

All of the motor control is grouped together in what is commonly known as "motor control centers." These centers which could be called "load centers" are fed directly by a primary feeder from the generating plant. In the same structure that contains the motor starters there are normally provided a lighting panel board and air-cooled transformers for plant-lighting requirements. These transformers may be built into place on top of the motor control center.

Motor controls.—Push-botton control is used on each motor starter and in particular instances, where the motor is not within sight of its starter, auxiliary push-button stations are

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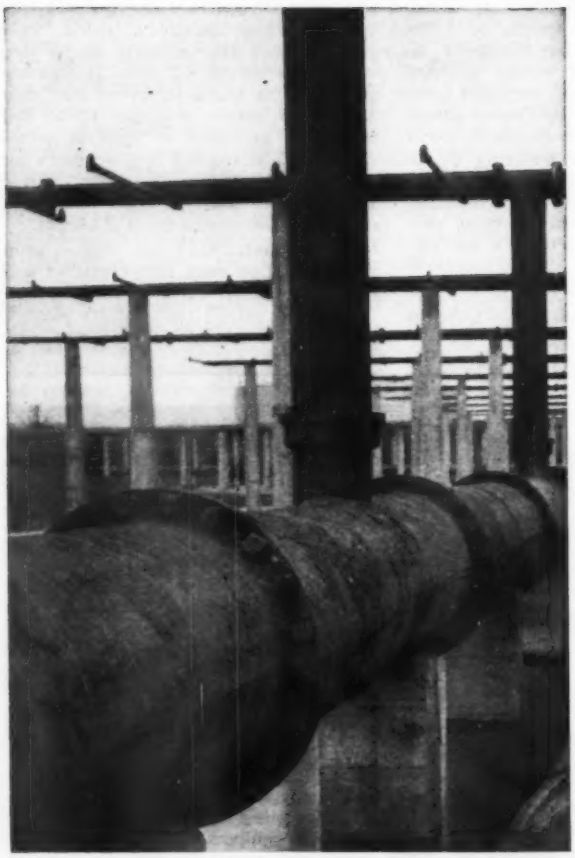

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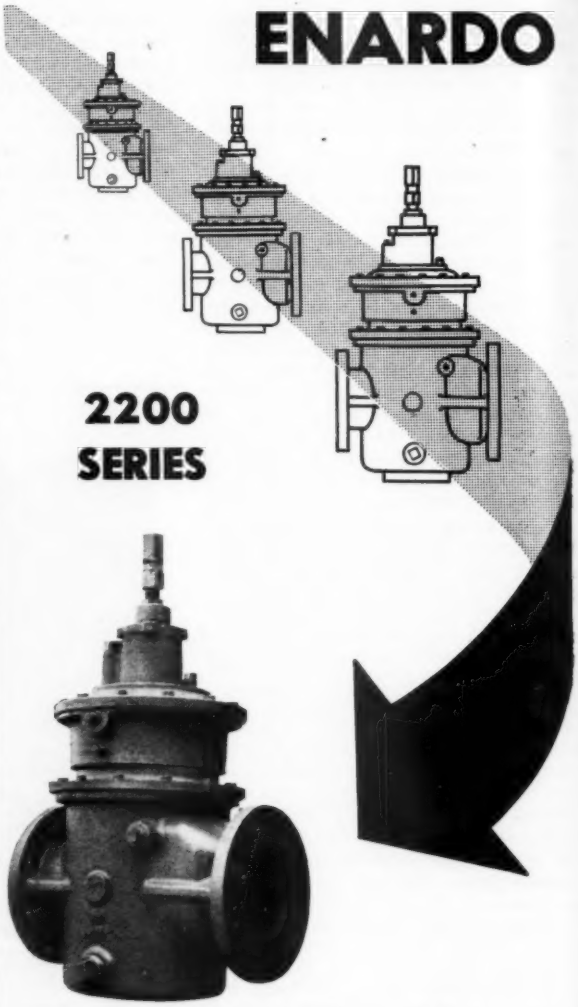

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used at the motor location as well as on the motor starter.

Motor wiring.—All motor wiring is neoprene jacketed cable in rigid conduit usually run underground. Motor wiring is usually sized according to the minimum requirements specified in the National Electric Code. However, in some cases, the sizes of wire to a particular motor may be increased in order to keep the voltage drop below 2 per cent. The primary feeder circuits from the generating plant to the various motor control centers are sized on the basis of the expected load increase in the control centers. Usually these primary feeders are 50 per cent oversize.

Circuit breakers.—The selection of overload protection and short-circuit protection is a major problem in the Southwest, the reason being that the ambient temperature surrounding the motor control centers at times approaches 125° F. Consequently, it is necessary to use a larger circuit-breaker rating than is normally recommended in order to prevent this circuit breaker from tripping out due to starting loads. Wire sizing is considered in this application, and the proper short-circuit protection of the motor is taken into consideration.

In the majority of cases increased size of circuit breaker is below 350 per cent of the full-load current required by a motor. In addition, it is necessary to use the next larger size overload heater element above the 125 per cent rating. This also is done to keep the starter from tripping during starting and/or during continuous full-load use. The additional heat produced in the motor control centers by all of the contracts and holding coils of the starters that are grouped together makes it almost mandatory to use the next size larger overload heater element above 125 per cent rating. In most cases the ambient temperature surrounding the motor is usually 15° to 20° F. below the ambient temperature surrounding the motor control center.

Lighting.—The lighting requirements for the various buildings and compressor station are set so that a minimum illumination of 10 to 15-ft. candles can be provided. In a compressor station requiring 10,000 hp., this means approximately 30 kw. of lighting is required, with the majority of the lighting in the compressor building itself.

Type RH wire is normally used for all light wiring, and the loading on any particular lighting circuit is kept within 75 per cent of the rating of the wire itself as listed by the National Electric Code. Vapor-tight lighting fixtures are used in a majority of cases, except where the lighting is in a hazardous location as described by the National Electric Code. In this case, Class 1, Group D lighting fixtures are used. As mentioned earlier, all of the lighting circuits are controlled from a central lighting panel board.

The power required by the employes' houses for lighting and appliances is based on the load requirement of 1 kw. per house. A 480-volt power feeder is used from the generating plant overhead to the employes' camp with stepdown transformers to a three-phase, four-wire, 120/208-volt distributing system. Each house is provided with a multibreaker panel board, usually consisting of four single-pole breakers, and an external fusible disconnect switch. The employes' houses are not individually metered; however, a master watt-hour meter is provided on the power feeder to the camp.

Electric meters.—The total kilowatt-hours of energy developed by the generating plant is measured each month by totalizing watt-hour meter. In addition, watt-hour meters are provided on each of the larger primary feeder circuits. Therefore, the amount of power required for cooling purposes, employes' houses, and miscellaneous purposes may be easily determined. The total load on the generating plant, considering one unit as a spare, is sufficient to give a load factor of between 75 and 90 per cent. Normally each individual engine-generator unit is loaded to approximately 85 per cent of its altitude derated full-load rating.

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Meter Maintenance

by J. J. Harris*

Magnolia Pipe Line follows program which has resulted in continued meter accuracy of plus or minus 0.05 per cent and lack of meter failures between repair periods

TO obtain high accuracy and uninterrupted performance with positive-displacement meters, a definite maintenance schedule must be included in the over-all meter program. Magnolia Pipe Line Co. has successfully metered mixtures of light-hydrocarbon products for over 10 years on its Longview-Beaumont 4-in. butane line, and petroleum products such as gasoline, kerosine, and diesel fuel for over 2 years on its Beaumont-Hearne 12-in. products line. It is felt that the over-all cost of the maintenance program has more than been repaid by the continued meter accuracy of plus or minus 0.05 per cent and by the absence of meter failures between scheduled repair periods.

General Maintenance Program

The general meter-maintenance program followed by this company includes such items as:

1. Periodic inspection and minor repairs of the meters.
2. Accurate records of meter performance such as meter factors, total throughput, and repairs.
3. Proper lubrication and critical meter parts.
4. Periodic blowdown or cleaning of accumulated water, rust, and scale in the meter body.
5. Careful inspection of the meter protective installations such as hay tanks, settling tanks, and filters.
6. Constant check of flow rates through the meters to insure that meter capacities are not exceeded.
7. Periodic running of standby meters or meters not in daily service.

All meters are inspected hourly for any unusual noises and for proper flow rates. A loud, noisy meter of the rotating-vane type generally indicates worn rotor and blade bearings. These bearings should be replaced before damage is caused to the blade edges or to the inner body. It has been Magnolia's experience that bearing wear is caused more by attrition of accumulated fine rust in the bearing body than the normal wear and tear. Whenever the accumulated rust, etc., can be prevented from settling out in the bearings, the meter life is increased greatly. For example, on the 4-in. butane line in which there is little, if any, internal corrosion, the meters ran for approximately 9 years with 5,850,000-bbl. throughput per meter without any shutdown time for bearing or blade repairs.

On the other hand, on the 12-in. products line in which internal corrosion is a major problam, some meter bearings have had to be replaced within a year's time and with only 500,000-bbl. throughput. Meters at other locations on the products line, however, have given better service, the best being 2 years' service and over 2,000,000 bbl. of throughput per meter with little signs of bearing wear to date.

Accurate records of the meter factors and total throughput are kept along with individual meter repairs. After a meter has been overhauled, it is adjusted to have a factor of 1,000 when metering the fluid having the highest throughput through the meter. This adjustment is sealed and is not reset during the periods between repairs, the meter factor being allowed to vary with different products and with normal wear. When the meter factor indicates that the meter is approximately 2 per cent slow, the inner element is removed from service, inspected, and repaired. Normally only the thrust and rotor bearings need replacement at this time at a cost of approximately $30. If the meters are allowed to run with the rotor, and thrust bearings worn, additional replacements of blades, blade bearings, and cam may become necessary at a far higher expense and in a relatively short time.

Lubrication of the particular type of meter in service with this company is simple but important. A weekly application of a light machine oil to the meter counter and calibrator and a semiannual application of glycerin to the liquid seal are the main items of the lubrication program. Due to the highly corrosive atmosphere of refineries, the weekly application of oil to the counter and calibrator in refinery service is vital to prevent corrosion and subsequent failure of these parts.

At one of our meter settings located in a refinery, five counters failed after the first 3 months of service due to corrosion products jamming a counterwheel shaft. Meters are blown down of any accumulated water, rust, or scale as often as necessary, usually once a week. This is one of the more important items of the maintenance program.

The small particles of iron oxide resulting from internal corrosion of the line (100 mesh or finer in size) have a tendency to "pack" and "blowing down" is not not too effective through water. In this case, the inner element is removed from the meter case and cleaned with particular attention to the bearings. As mentioned above, the fine particles do great damage to the meter bearings if allowed to accumulate.

Hourly checks are kept on the condition of meter-protective devices such as hay tanks, settling tanks, and filters by noting the differential pressure drops. Special care is taken in packing the hay tanks to prevent any "channeling" of the fluid through the hay; 100-mesh brass screens are used in the filter in place of the conventional felts.

It is thought that the filters on the market today could be improved considerably for products-line service. The cost of maintaining and cleaning filters using mesh screen must be balanced against cost of meter repairs due to iron-oxide wear on the bearings. If large-mesh screen is used, the cost of meter repairs will increase. If small-mesh screen is used, filters will have to be cleaned more frequently and labor charges will increase. There are filters available today that will screen out particles as small as 15-20μ. The cost of maintaining such a filter in products-line service, however, would probably be excessive in view of the small cost of changing the meter bearings after 2,000,000 to 3,000,000 bbl. of throughput.

Flow rates are checked on the meters hourly for several reasons: (1) The meter factor is affected to some degree by the varying rates. (2) If the meter is run over capacity for too long a period, the cost of repairs is very high due to damage to the meter blades. (3) Plugging of the filters is one of the main causes of varying flow rates in our system.

It has been this company's practice to run all standby meters as often as possible. It is thought that greater harm is done to the meter by having it lie idle and possibly corroding than would be done by running it continuously in a fairly clean stream and at the normal rate. In the examples given above for the products

*Mechanical engineer, Magnolia Pipe Line Co., Houston.

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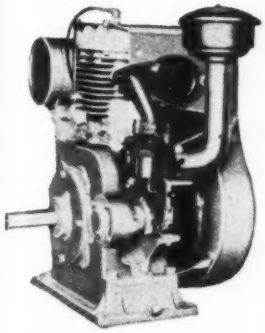

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line, the meters at both locations were similarly protected by filters, etc. They were given the same amount of attention and maintenance; and they were metering the same types of fluids. The meters giving only 500,000-bbl. throughput before repairs were idle 75 per cent of the time; the meters giving uninterrupted service for over 2,000,000-bbl. throughput and still in service were idle only 25 per cent of the time.

Cost of Meter Repairs and Maintenance

The cost of meter repairs on the 4-in. butane line has been almost insignificant over the 10-year period of operation. The actual cost of meter repairs and maintenance including labor has averaged approximately 0.003 cents per barrel throughput. Shutdowns due to meter failure have been very infrequent. Labor charges are very low due to the fact that the greater portion of the repairs were made by personnel required for calibration at a time when the meters were to be calibrated. It is estimated that this cost will neither increase nor decrease in the future.

Meter repairs and maintenance including labor on the 12-in. products line over a period of 2 years have averaged approximately 0.004 cents per barrel throughput or 33 per cent greater than the average for the meters in butane service. It is estimated that this average cost will decrease in the future to a figure comparable to that of the butane meters due to decrease in the amount of rust particles in the stream. The use of scrapers and inhibitor is proving very beneficial in eliminating rust. The major item of most repairs in products-line service is the replacement of the rotor and thrust bearings worn by the rust particles settling in the bearings.

Responsibility for the meter-maintenance program is delegated to an engineer located at the Beaumont office. It is estimated that 2 man-days are required each month for the maintenance and repair of eighteen 4-in. meters and two 3-in. meters. Calibration of the meters is left to the operating personnel, and the expense of calibration is not included in any of the above cost figures.

Summary

Accuracy and uninterrupted performance of positive-displacement meters depends largely upon correct operation and a preventive-maintenance program. The cost of meter maintenance and repairs will average 0.003 to 0.004 cents per barrel throughput of meters in petroleum products service. Some of the major items of a preventive-maintenance program should include periodic inspection and cleaning of the meters and meter-protective devices, proper operation of meters, and frequent running of all meters wherever possible.

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Interprovincial Pipe Line

(Continued from page 208)

made in initial investment and operating costs without impairing the throughput capacity of the line.

Specifications of material. — With the route and extent of the project settled, the general specifications of materials to be used were made for the line itself and for the pumping stations. The pipe is of high-test steel being turned out in 40-ft. joints with ends beveled ready for the welders on the right-of-way. These joints are longitudinally welded and cold expanded by internal hydraulic expansion which substantially increases the yield point. The steel specifications call on .20 to .25 carbon and .50 to .75 manganese.

After investigations of the various materials available to protect the pipe from corrosion, it was decided to coat the line with coal-tar enamel, reinforced with a fiber-glass material and with a coal tar impregnated asbestos wrapper. The enamel, known as Bitumastic 70-B enamel, is produced in Canada.

All available data and general information were gathered regarding depth of frost penetration throughout the pipe-line route and it was decided

PROGRESS ON CONSTRUCTION OF INTERPROVINCIAL PIPE LINE CO. CRUDE-OIL LINE AS OF AUGUST 1, 1950

	Ditched	Welded	Coated and wrapped	Back-filled
Western division (Edmonton to Regina)	293	275	271	263
Central division (Regina to Gretna)	211	207	200	199
Eastern division (Gretna to Superior)	123	137	132	109
Totals	627	619	603	571

that 3 ft. of dirt covering on top of the pipe would provide reasonable winter operating temperatures of the oil, of 25° to 30° F. This cover also would provide adequate protection to the line from damage due to farmers plowing their fields or hauling equipment back and forth across the pipeline route.

At this stage, then, the decision had been reached to build the section from Edmonton to Regina of 20-in. diameter pipe with an intermediate pumping station at Kerrobert, Sask. From Regina to the international boundary at Gretna, Man., the pipe would be 16-in. diameter and an intermediate station at Cromer was included. The station at Gretna would pump through 18-in. diameter pipe to a station at Clearbrook, Minn., which would in turn relay the oil to Superior, also through 18-in. pipe.

Thus, there are three sections of the line—roughly 450 miles of 20-in., of which 82 miles has a wall thickness of 11/32 in., the remainder 5/16 in.; 340 miles of 16-in., with 5/16-in. wall; and 360 miles of 18-in. pipe, all of which is 9/32-in.

Six stations along the route would keep the oil moving with an initial capacity of 90,000 bbl. a day from Edmonton to Regina and approximately 70,000 bbl. a day in the sections east of there. This can be increased by 50 per cent through the addition of six more stations.

Special attention was given to the pipe and its protection at river crossings. Pipe with ½-in. wall was selected for these crossings and concrete river weights are added to keep the pipe in the river bed and prevent movement or floating during flood periods. Crossings of the North Saskatchewan River near Edmonton and the Battle River, near Hardisty, Alta., were completed late last winter with construction crews operating from the frozen river surface. An early thaw delayed the crossing of the South Saskatchewan River, and this section of the line will be put in during a low-water period this summer.

All of the oil scheduled to move out of the terminal at Superior is to move by lake tanker and since this could only move during the summer months, when the lakes were not ice bound, sufficient storage was needed at the terminal to permit operation of the line during the winter months. To provide this, 12 tanks, each with a capacity of 150,000 bbl., are to be erected which will make storage space available for 1,800,000 bbl. of crude. Loading facilities at Superior have been designed to put oil on board the lake tankers at the rate of 20,000 bbl. an hour.

Pumping Stations

Planning the pumping stations presented many different problems and involved conferences with various equipment manufacturers. In view of the extreme weather conditions to be encountered throughout the pipeline route, it was decided that the pump station buildings should be of steel frame and masonry walls and be unitized as much as possible. Considerable attention was given to the heating system for the buildings, which will be about 75 by 200 ft. by 24 ft. high.

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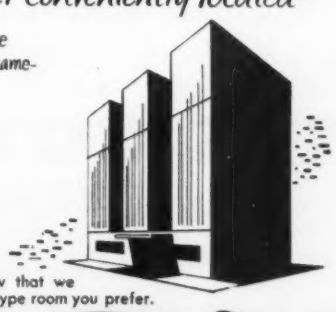

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from waste-heat boilers, one to each engine, absorbing heat from the exhaust gases and generating steam at approximately 15 lb. pressure. These waste-heat boilers will produce approximately 1 lb. of steam per operating horsepower and will be supplemented by automatic oil-fired boilers.

It was decided that three complete pumping units, operating in series, would provide the greatest flexibility of operation under all load conditions, with good operating economy and at an appreciably lower first cost. This in-series setup comprises a diesel engine of sufficient horsepower driving through a speed increaser to a single-stage centrifugal pump.

Diesel engines — or dual-fuel engines where natural gas is available —were chosen in preference to electrical drive after making economic studies of the types of operation, giving due consideration to flexibility of the diesel drive and the natural hazards such as weather conditions, etc., involved in the remote parts of the country where the pumping stations will be located.

For the Edmonton and Kerrobert stations, four units consisting of four dual-fuel engines each rated at 1,080 hp. at 600 r.p.m., driving four 8 by 10 by 16 centrifugal pumps, are to be installed, thus providing a standby unit at all times. At the Regina and Cromer stations, three units rated at 810 hp. are to be erected now but provisions are being made to install the fourth as a standby unit at a future date. The Gretna station will have three 540-hp. units while at Clearbrook only two 810-hp. units can handle the initial load.

Auxiliary Equipment

In order to make the operation of the pumping stations as dependable as possible, considerable time was spent in the design of the engine-jacket water-cooling system, the engine-lubricating cooling system, the engine fuel-oil-purification system, and automatic controls were provided to shut down the units in case of failure in these auxiliaries.

As the type of design of the system is what is known as the "closed system" with no relief tankage floating on the line, instrumentation has been designed to hold pressure surges to a minimum. By means of a high flow metering device on the discharge of each station a warning can be given to the station personnel of a major line break or leak downstream from that station.

These are just some of the many studies and plans completed by the engineering group and all reasonable efforts have been made to design an efficient and modern pipe-line system.

While these engineering studies were progressing, other groups were going about the study of different phases of the work. There was the organization of Interprovincial Pipe Line Co. itself, as future owner and operator of the underground transportation system. Officials of Imperial Oil, Ltd., made the first moves toward the realization of a pipe line, but that company was not then and is not now interested in getting into the pipe line business as such.

But as one of the major producers of crude in the new oil fields, Imperial had a major stage involved in the proposed new outlet to market. Imperial, therefore, promoted the organization of Interprovincial but retained only a one-third ownership in the new company. Twenty-five per cent interest rests with other oil companies and private interests and 42 per cent is in the hands of the public.

Work at High Speed

Now the stage has been reached after those long months of planning and designing when some 1,500 construction workers are racing against time to complete the entire pipe-line system by fall. To build the full 1,180 miles of pipe line, a work schedule of 150 days was set because of the short construction season in this part of the world. That 150-day schedule makes this the fastest major pipe-line construction job ever undertaken. Other larger and longer lines have

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been built but not in the limited time stipulated on this job.

In order to meet the program, the pipe line was divided into three divisions for construction purposes. The contract for the 450-mile section from Edmonton to Regina was awarded to Bechtel Corp. of San Francisco in affiliation with Fred Mannix & Co., Ltd,. of Calgary; the contract on the 340-mile leg from Regina to Gretna, Man., went to Williams Bros. Corp., Tulsa, and the 360-mile section from Gretna to Superior is being built by Anderson Bros., Houston.

These firms, with long experience in pipe-line construction, had the "know how," the specialized machinery which was not available in Canada, and the trained personnel, who hold the key positions on the job. While these experts came from the United States to direct the work, 80 per cent of the manpower now engaged on pipe-line construction is Canadian, hired locally along the route, wherever possible.

The three contractors, working in three divisions, have in turn split their working units into three separate spreads of men and machinery. Thus, nine spreads are building the line and they are completing better than 9 miles of pipe-line construction every 24 hours of favorable weather. This is the work schedule set months ago during the planning stage.

By the end of June a total of 350 miles of pipe had been welded, or roughly one-third of the entire line. The western division, where 20-in. pipe is being laid, has accounted for most of this progress since floods in southern Manitoba and unseasonable snows and a late spring delayed the start of work on other eastern spreads. But all work now is keyed to the original timetable which will see the line completed on schedule late this year.

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Progress on Pumping Stations

Work is also progressing rapidly on six pumping stations. Five of these in Canada—at Edmonton, Kerrobert, and Regina, Sask., and Cromer and Gretna, Man.—are being built by Bird Construction Co., Ltd., a western Canadian firm. The sixth station at Clearbrook, Minn., is being built by Walco Engineering & Construction Co., of Tulsa.

The structural steel and roofing have been completed on the Edmonton and Kerrobert stations and foundation work is progressing on the others. At the Edmonton station six tanks of 140,000-bbl. capacity each have been completed to give 840,000 bbl. of storage there and work has started at the Superior terminal on the 12 tanks of 150,000-bbl. capacity each, which will provide the 1,800,000 bbl. of storage needed there.

It is not only the short construction season that makes this project an urgent one; its influence on Canadian economy is a vital consideration. Successful exploration and the extremely rapid development programs which followed the Leduc discovery have built western Canada's proven oil reserves to an estimated 1 billion barrels. In 1946 reserves were placed at 72 million barrels. Stated another way, potential oil production in Alberta at the beginning of 1950 was more than one-third of Canada's requirements, while 3 years earlier Canada produced less than one-tenth of the oil she used.

The current rate of development is best illustrated by the figures on the oil industry operations so far this year. From the beginning of the year to June 30, a total of 401 wells were completed in Alberta. Fifteen of those were gas wells, 86 were dry and unproductive, and 300 were successful oil wells—that is 300 new wells in the first 181 days of this year.

Because a high transportation penalty prohibits the economical marketing of Alberta crude outside the prairie region, the daily average production from the western oil fields is held to about 61,000 bbl., sufficient to serve prairie refineries.

That is a limit placed on production by the market available. The wells in Alberta could currently be producing more than double the present rate and still remain within the allowables fixed on wells by the Alberta Conservation Board. Until a pipe line is completed and oil reaches out economically to new markets,

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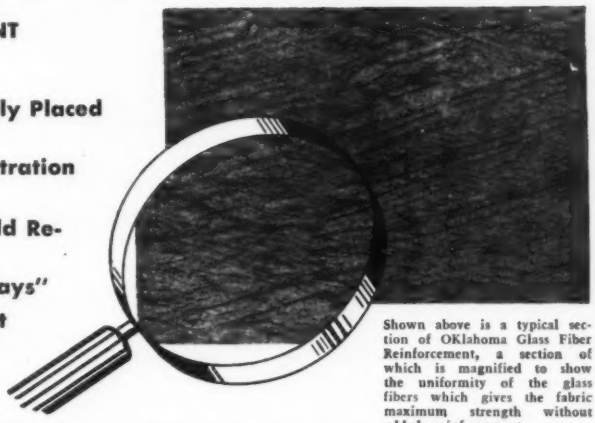

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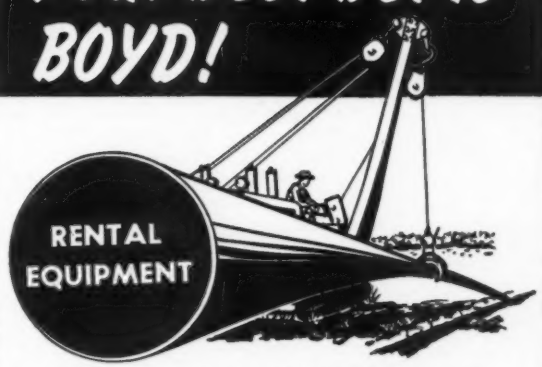

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producers will have about one-half of their productive capacity shut in.

In the last 10 years, Canadian oil consumption has increased 130 per cent. Demand for gasoline has doubled and heating-oil demand has been increased three and one-half times. But because gaps exist in refining capacity and transportation, and in spite of growing reserves, less than 20 per cent of Canada's petroleum needs can be supplied with domestic crude. The pipe line will go a long way toward filling the transportation gap and getting more of Canada's own crude into Canadian markets. For the pipe line, like the railroads, operating as a common carrier, will move crude for any producer or shipper who meets standard regulations, and on arrival at Superior, the oil will be loaded onto tankers to continue its eastward journey to refineries in the Sarnia, Ont., area.

Unlike a railroad, however, a pipe line's traffic is strictly one-way. Oil-producing areas are the only points of origin for traffic on the pipe line. It transports one commodity in one direction with no possibility of a back-haul, while with other transportation agencies, each railroad station or bus stop is an origin for traffic and the vehicles can turn around and haul back the way they came if they wish.

Western oil is benefiting the exchange problem by about 100 million scarce United States dollars this year. This means more money to buy other imports needed—things that cannot be grown or made in Canada. It is expected this benefit to the dominion's exchange position will be increased by 55 million dollars in 1951 with additional Canadian crude moving to market through the pipe line.

Of the $90,000,000 that the pipe line will cost, it is estimated that 30 per cent will be spent in direct-labor payrolls. This is going to mean more money in communities all along the line with resultant benefits to the business activity of those areas. But that benefit, while considerable, will be temporary and, therefore, will be but a flash in the pan compared to the lasting benefits which will result from completion of this project.

Sharply increased production from wells in the now oil fields of the west is foreseen and it is estimated when oil starts moving on the lakes in 1951 western production can increase to at least 100,000 bbl. a day. To get this crude into the new and distant markets and in spite of lower transportation costs, the producers in the field will receive slightly less per barrel for their crude.

The greater volume produced, however, will increase their income by about $3,000,000 a month. At the same time crude prices to the prairie refineries will be reduced which will result in ultimate savings to the consumers.

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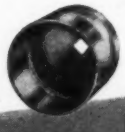

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How Northern Natural Achieves

HIGH-QUALITY WELDS

L. J. CUNNINGHAM

Assistant superintendent of pipe lines, Northern Natural Gas Co., Omaha.

. . . "A pipe line is as strong as its weakest weld." Here an official of a large natural-gas company discusses the technique of good welding

by L. J. Cunningham

PIPE-LINE Section

NORTHERN NATURAL GAS CO. makes every effort to obtain the highest quality welds possible on its pipe lines. The importance is realized of the truism that a pipe line is as strong as its weakest weld.

In the past decade much time and thought have been devoted to the science of pipe-line welding. Experiments have been made into welding techniques. The results have been gratifying. For our part, the excellent status of welding is evidenced by the fact that Northern has a record of no interruption of service due to weld failure on pipe lines since Northern began the practice of laying solid welded lines in 1939.

Early last year Northern started making experimental test welds on the pipe to be used in the construction program for that year. In an effort to simulate weather conditions that might be encountered on the pipe line right-of-way, welds were made under various atmospheric conditions. They were made indoors at a moderate 70° F. and outdoors under the conditions of high winds, cold, and snow. Electrodes were selected on the basis of the results obtained from these extensive tests.

Construction work was started in June 1949 on a 24-in. loop line north of Ogden, Utah. Welders made qualification tests with good results but about the third day we found cracks in the second pass of almost every weld. We immediately consulted metallurgists and were informed that the cracking could be due to molybdenum-content electrodes. We immediately changed from Class E7010 to E8010 electrodes but we did not gain relief from the cracks. We tried preheating but still the cracks continued to appear.

We changed back to E7010 electrodes but had the second pass applied in a manner to leave a convex or oval top rather than concave as before. The theory behind the oval topped second pass was that it would leave a thicker metal deposit through the root of the weld. The cracking stopped. We feel that the described procedure was beneficial but we do not make any claims that this method is a cureall or infallable. There were few welds cut out of the line due to cracks.

Radiographic inspection was used to determine if the penetration of the third pass was of a depth beyond that of the crack. Any weld that has a crack extending into the stringer pass was removed by cutting it out of the line. Through visual inspection of sectional specimens of cracked areas we found that the greatest depth of the cracks was approximately 1/32 in.

Second Pass Applied

In Northern's current 1950 pipe-line-construction program we have not encountered cracks, but found it necessary to apply the second pass to avoid broken stringer beads. We believe that the quality of welding is substantially improved through the application of the second pass immediately after the root pass, with never more than 10 joints between the second-pass crew and the pipe gang. This space is closed at the end of the day so that no joints with root pass only are allowed to remain overnight.

We have found that even where only the end joint was left overnight with only the root pass made, it would break and roll off the skids during the night. This alone warrants running the second pass on all welds as soon as possible after the root pass is made.

The experience cited is contrary to our previous belief for many years that we should not have more than three welders involved in making a complete weld; the two stringer-bead or root-pass welders and one finish welder. We are now thoroughly convinced that the quality of the weld is improved greatly by using welders for each specific operation, i.e., stringer bead, second pass, and finish.

It has been the customary practice for many years to select welders highly skilled in running stringer beads. This can also apply to the welders selected to apply the second pass. If they only have the one operation to perform they can reach a high degree of proficiency by the constant performance of the same operation. In other words, it can be compared to mass production by the automobile manufacturers. They found that men trained to perform specific duties on the assembly line could step up production to an almost unbelievable volume and yet improve the quality of their product.

The entrance of X-ray and radiography into pipe-line welding has made it necessary to revise most, if not all, pipe-line welding specifications, particularly where it is specified that no defects are allowed. Through the use of X-ray or gamma ray we find that slight defects are present in almost every weld that is made.

A program for standardizing pipe-line welding specifications has been under way for some time by subcommittees set up by A.G.A., A.P.I., and Associated Pipe Line Contractors of America. The three groups have spent much time and effort in the drafting of a welding specification that would be acceptable to the entire industry.

At the present time there seems to be considerable difference in the opinions of various companies on proper dimensions of pipe welds, as to width and height. This makes it difficult for pipe-line welders. For instance, consider a crew of welders which finish a job for a company specifying that a weld on thin-wall, large-diameter pipe be ¾ to 1 in. wide. The welders then move onto a job for another company with specifications for a weld ½ to ⅝ in. in width, on the same kind and size of pipe. Here

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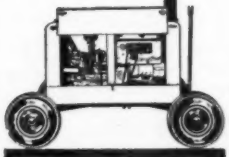

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the welder is very likely to displease the inspector on the qualification test, because he has concentrated on the wide weld technique, perhaps for months. Then in a matter of hours he is asked to make a test weld which requires an abrupt change in technique. It is obvious that failure is possible if not probable. By the same token, the arrangement if reversed and the welder is moved from a job requiring the narrower welds to a job requiring wide welds, just as much difficulty is caused. It is the opinion of the writer that personal preference should be disregarded in determining the dimensions of welds. The results obtained from actual experimental test welds should govern welding techniques.

The small, narrow weld will meet ductility and tensile requirements and since the heating period for making the weld is considerably shorter, it seems obvious that stress accumulation in the weld area would be less. The present trend toward higher-strength pipe and thin sidewalls has made it necessary that procedure for welding be carefully considered.

On the basis of many experimental test welds we are thoroughly convinced that the wide weld is a waste of time and material, as well as detrimental because of locked-in stresses and strains which are greater, due to the prolonged heating period required to make the larger weld.

Marine Terminal

(Continued from page 213)

Sidon terminal is installed by Williams Brothers Overseas Co.

There are over 31 miles of pipe lines on the terminal property, consisting of 3 miles of 30-in. incoming filling line; 10 miles of 30-in. crude-oil lines between tanks and seashore; 10 miles of 12¾ to 18-in. fuel-oil lines between tanks and seashore; 4 miles of 30-in. submarine crude-oil loading lines, and 4 miles of 12¾ to 18-in. submerged fuel-oil receiving and loading lines. There is a manifold in the tank farm for switching streams between tanks and another on the seashore for switching streams between berths. These two manifolds and other piping contain a total of 134 large valves.

Crude-oil loading will be done entirely by gravity; no pumps are required because the tanks are located on top of a hill which is 370 ft. above sea level.

The rates at which crude oil will be loaded have been estimated as 20,000 bbl. maximum and 15,000 bbl. average per day at each berth. Grand total for all four berths loading simultaneously would be 80,000 bbl. maximum and 60,000 bbl. average daily. Average tankers will carry 120,000 bbl.; larger types, 240,000 bbl.

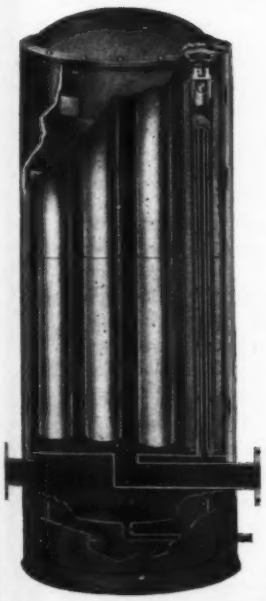
Fuel oils will be loaded from the three 14,000-bbl. tanks near the seashore, with four 260-hp. diesel-driven centrifugal pumps, each with capacity of 5,500 bbl. per hour.

Accurate control will be maintained on the flow through each loading line by means of push-button operation of two 16-in. electrically operated plug valves on double "Y" connections near the manifold. This advanced type of electrical valve manipulation makes possible a sensitive control of flow.

At the control house, just above the manifold, high and low tank level alarms ring bells and flash red lights. The tank-farm manifold control house is the heart of operations. Messages are received there from the shore manifold for the opening and closing of valves. It is expected that two control operators will be on duty together.

Communication facilities consist of a submarine - rubber - coated copper telephone circuit between dispatcher's office on shore and each berth; radiotelephone receiving and transmitting stations with towers; and voice channels between ship and shore. The electric power plant is equipped with five Caterpillar diesel-engine-driven generators (100 kva. each) which were salvaged from pipe-line construction camps. Water supply and fire protection system consists of one 80,000-gal. water tank on a 70-ft. tower, one fire

HONAN-CRANE Oil Purification offers



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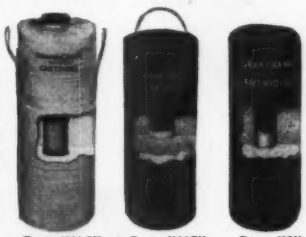
Multiple-cartridge purifier, available in eleven sizes using 1 to 24 cartridges. Provides high flow rate and is designed to use easy-to-change "MC", "MF", or "S" type cartridges.



Type "MC" Type "MF" Type "S"

Honan-Crane Type "MC" Cartridge
"MC" Cartridge is a woven cotton bag containing 15 pounds of Cranite (specially processed fullers earth). Solids and abrasives as well as soluble products of oxidation such as asphaltenes, resins and acids are removed from the oil.

Honan-Crane Type "MF" Cartridge
"MF" Cartridge is a perforated metal basket lined with a woven cotton sock material and uniformly packed with Palconia (specially selected cellulose fiber filtering medium). Complete removal of solids such as abrasives, scale and other foreign matter.

Honan-Crane Type "S" Cartridge
Type "S" Cartridge contains 4½ pounds of Palconia tightly packed in a specially woven cotton sock material. Performance of the cartridge is comparable to the "MF" cartridge in removal of abrasives, scale and other foreign solids.

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Shown at the left is a Console Control Desk which is one of several being built by us for service in the pumping stations of a major pipe line company.

This desk provides automatic sequence control of valves and pumps when used in conjunction with high and low voltage motor control equipment.

Appearing on the top of the console is a diagram of the piping layout of the station which gives a visual picture of operations by means of indicating lights. These lights also reveal any abnormal conditions such as high bearing temperatures, low suction or high discharge pressures and motor overloads. The surface of the desk top is flat except for the projection of the push button stations, all indicating lights being mounted on the under side of the desk top.

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pump direct connected to a 100-hp. motor, and the water lines. Construction-camp structures will be converted into warehouses, shops, laboratory, office and living quarters, etc., for terminal operations.

Submarine Lines

The submarine loading-line installation when completed this year will consist of four crude-oil-loading lines; two 20-in. and two 30-in. There will be bunker facilities at each of the four crude-oil-loading berths. One of these will have an 18-in. fuel-oil line and a 12-in. diesel-oil line; the other three will each have a 12-in. fuel-oil line and a 12-in. diesel-oil line.

Each of the four crude-oil loading lines has 200 ft. of 12-in. i.d. loading hose, 58 lb. per foot. Likewise, two of the berths each have 200 ft. of 12-in. hose for loading fuel oil and two have 200 ft. of 8-in. hose. For mooring ships at each berth there are five heavy steel buoys each anchored by 540 ft. of chain to two 5-ton Danforth anchors. The anchor chain is 2⅞ in. weighing 80 lb. per foot. Submerged pipe lines are provided with concrete clamps at intervals for preventing string currents from shifting the lines across the sea bottom.

Submarine Line Launching

The procedure for pulling submarine loading lines to offshore positions was watched with much interest since it was accomplished without the aid of a tanker or other large ship for towing purposes. By doing the job without a tanker, there was considerable saving in expense for the reason that the routing of a tanker must be planned far in advance so it may be available on the day when line pulling operations are scheduled. If there should be a delay due to rough sea or other causes, expensive tanker demurrage charges accrue.

The 20-in. lines to two of the berths have 0.812-wall, 167-lb. pipe; the 30-in. lines to the other two berths have ⅜-in. wall, 118-lb. For handling on the track, dollies are spaced at 40-ft. intervals for 20-in. and 55-ft. intervals for 30-in. pipe.

In advance of pulling the submarine lines to tanker moorings approximately 1 mile offshore, the pipe was welded in three strings and coating. One of these sections rested on dollies on a temporary half-mile-long narrow-gage railroad track sloping from the foothills to the shore. The other two strings lay parallel, on skids ready to be mounted successively on the dollies. The railroad is only ½ mile long because of hills rising abruptly from the Littoral area. At the Tripoli marine terminal of Iraq Petroleum Co., Ltd., 60 miles north of Sidon, there was sufficient distance to allow placing the full length of submarine pipe on dollies when its submarine lines were pulled in 1927.

Before placing Tapline's pipe sections on the dollies, the pipe was cleaned and primed, flood coated with asphalt, wrapped with glass mat, given a second coat of asphalt, a wrapping of asbestos felt, and a final wrap of asphalt-saturated heavy asbestos fiber applied in 3 by 8-ft. sheets.

Constant communication was maintained by radio telephone between the two 165-hp. tug boats and the shore control tower. Signals to tractor drivers were by flags; red meant stop, white meant pull.

The ½-mile sections moved down to the sea easily on dollies traveling on the temporary narrow-gage railroad, sloping downward toward the water's edge.

Movement of the pipe on the railroad was accelerated or stopped by four large tractors, with winch lines lashed to the pipe so that two of the tractors pulled the pipe outward while the other two snubbed or stopped it when necessary.

The empty 20-in. pipe was buoyed by pontoons at 250-ft. intervals. Air in 30-in. pipe provides buoyancy of 200 lb. per foot, sufficient to float it.

At the lower end of the track the pipe passed over a dry pit into which the dollies dropped and were retrieved.

Beyond the pit, the pipe passed through a 36-in.-diameter steel throat guide. The throat was lubricated with grease as frequently as needed. This steel throat is a departure from a

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customary practice of using a wooden throat for holding pipe in the desired alignment.

Straightening Floating Lines

To hold each line straight before lowering, ¾-in. guy lines were attached to 50 Danforth anchors set in pairs. The anchors were set in position on the sea bottom a week in advance and marked by buoys attached to manila lines.

Sinking Submarine Lines

The 30-in. lines were lowered by opening a 6-in. valve at the seaward end, admitting water which lowered them gently. Since an empty 30-in. pipe floats easily, only one pontoon was used at the outer end of the line. The 20-in. lines were lowered by filling with water from the landward end. Then they were lowered from the pontoons spaced at 250-ft. intervals to support the empty 20-in. pipe which is heavier than water. After a 20-in. line was on bottom a diver opened a blind flange at the outer end and then replaced it to prevent the line from filling with sand.

Final Anchoring

Pipe "anchors" made of concrete blocks with adequate clearance were attached to the pipe. Normally they do not touch the pipe. Each anchor consists of two 1½-yd. blocks of concrete. They are cheap and effective.

When the anchors were placed over the pipe at 250-ft. intervals, a diver rode the block downward until it was within a few feet of the pipe. Then he stood to one side and telephoned his directions to the work barge so that the block could be correctly placed.

Launching Time

Pulling was done at a speed of about 90 ft. per minute which means that each section was pulled in somewhat less than half an hour. In addition to the period for straight pulling, time was required for shifting the next section over on the dollies, welding sections together, and the application of coating to the bare space at tiein welds.

After each line was pulled to its position, the operations for straightening, anchoring, and lowering required 4 hours.

Highway and Railroad

A good motor-vehicle highway between Beirut and Tyre crosses the terminal site near the seashore. A well-ballasted standard-gage railroad also crosses the terminal site near the seashore. The railroad is owned by the Government of Lebanon. It was built by the British Occupation Army during World War II as a connecting link of a through system from Cairo via Beirut, Tripoli, Aleppo, and Ankara to Istanbul. However, it was never used extensively and at present the only traffic is occasional local freight movements from Beirut to Tripoli or Tyre and intermediate coastal towns. However, the roadbed is in splendid condition.

Tapline's Archeological Excavations

There are many ruins and relics of Phoenician occupancy of the Levant along the Mediterranean coast all the way between the Egyptian and Turkish borders. While excavating trenches for pipe lines near the seashore, a number of Phoenician burial urns and other antiquities were unearthed. Possibly the most interesting discovery was the mosaic tile floor of a Greek Orthodox church, which according to inscriptions, was erected in the year 551 A.D. Presumably the superstructure of the building was destroyed by an earthquake which did a great deal of damage along the coast in the year 555 A.D. The archeological department of the Lebanese Government has removed this interesting mosaic floor and reconstructed it in the courtyard of the National Museum.

Pipe-Line Lingo

Mechanics maintaining trucks and tractors are "maniacs"; a surveyor is a "squinter," a welder is a "spark idiot."

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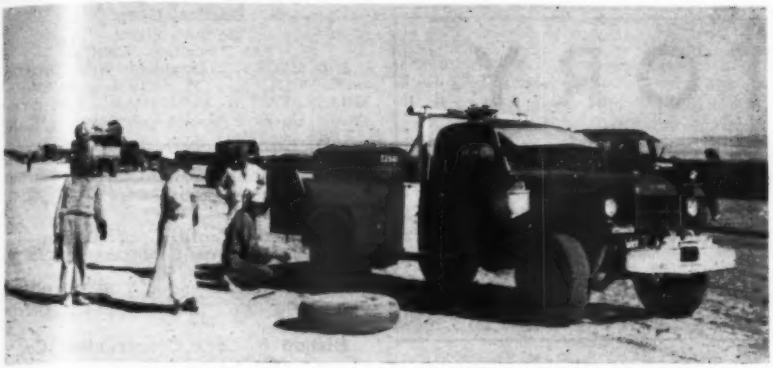

Changing heavy tire of welding-unit truck during Tapline pipe laying in Saudi Arabia.

Logistics Posed Real Problems During Building of Tapline

by Paul Reed
Pipe-Line Editor

AN entire self-contained organization had to be built for Tapline from the ground up to provide for all phases of procurement of materials, marine transportation, and delivery to construction locations. Because of the long time elapsing from initial specification, planning for all steps had to be done months in advance for transportation, construction, repairs, housing, food, and a wide variety of supplies. All perishable foods are moved in large refrigerator trucks known as "reefers."

Much of the success in attaining steady, smooth construction may be attributed to adequate advanced planning for trucks and tires.

If trucks and tires customarily used in the United States had been employed, there would have been a whole series of troubles due to interruptions in the flow of supplies which would have seriously impeded progress.

By having a heavy logging type of truck especially developed by the Kenworth Motor Truck Corp. under Aramco supervision it was possible to get adequate overland transportation. These trucks, powered by 290-hp. Hall-Scott motors, are too wide and too heavy for United States highways. Tapline hauling costs are as low as 5 cents per ton-mile while the smaller loads permissible in the United States entail costs which seldom go below 10 cents per ton-mile. For Aramco and Tapline service the gross weight of truck and trailer load could be 120,000 lb.; in the United States, 90,000-lb. loads are about the legal maximum. Tapline trucks were modified so that dollies could be mounted for the return trip to save the roads and the dolly tires.

PIPE-LINE Section

Pipe trucks haul 10 joints of ¼-in. wall, nine joints of 5/16-in. wall, and seven joints of ⅜-in. wall. There were 175 truck units altogether of which 27 were 10-yard dump trucks and 148 were in pipe hauling and general service.

These trucks have a 6-ft.-long tank made of a nipple of 30-in. pipe which holds 250 gal. A winch on the side of the cab pulls up the heavy 12-ply sand tires to a mounting position.

These tires are so heavy that punctured tires can only be lifted to hang in the spare-tire rack by utilizing the winch and crane carried by the convoy leader. Approximately 43 per cent of tire failures came from punctures, mostly from welding rods, until the highway was patrolled by a magnet truck. Loaded trucks carry 35-lb. pressure in tires; unloaded, 25 lb. The need for reliable transportation has justified Tapline's $2,000,000 investment in tires.

Pipe and other equipment have been shipped on trucks, driven by Arabs, which move in convoys, each of which is supervised by an American. Convoys stop at check points along the route to facilitate servicing, inspection, and control of the convoy.

Unloading of 30 and 31-in. pipe from ships at Beirut, Lebanon, for Tapline was done at the fast rate of 2,500 to 2,600 tons daily, according to David R. Williams, vice president, Williams Brothers Overseas Co., who regards this as an outstanding accomplishment in the experience of his firm in foreign ports. Arab stevedores with adequate equipment pushed the work for effective unloading through five hatches simultaneously without dei.ting or damaging.

From the docks at Beirut pipe was shipped by narrow-gage railroad as far as Mafraq, Syria, at the rate of 1,500 tons on 100 cars per week which was the limit of these facilities.

The remainder of the pipe was trucked over mountain roads. Manifests for deliveries as far east as Graver Construction Co. operations at Turaif, Saudi Arabia, had to be made out in Arabic to meet requirements of four countries—Lebanon, Syria, Jordan, and Saudi Arabia.

BOOKS

WHEN TO DRAIN.— Published by Petroleum Educational Institute, 9020 Melrose Avenue, Los Angeles. 54 pp. $.50.

This booklet is based on a sound filmstrip of the same title which was prepared by the publishers. All of the important factors which influence the drain period are thoroughly explained. In addition, many of the technical data and tests which have been published in recent years on the subject are explained. Throughout, emphasis is placed in cost of maintenance.

HOLDINGS IN THE A. F. DAVIS WELDING LIBRARY. By Robert S. Green. Published by Ohio State University Engineering Experiment Station. 37 pp.

This publication is made in answer to requests for information on published works in the welding field and those fields contributing to the art and science of welding. The list of titles is not meant to be a complete bibliography of the field but is published to assist corporations, individuals, and other libraries in using the Davis library or in building their own collection.

PETROLEUM PRODUCTION ENGINEERING: PETROLEUM PRODUCTION ECONOMICS. By Lester Charles Uren. Published by McGraw-Hill Book Co., 330 West 42nd Street, New York 18. 639 pp. $7.50.

The third volume of the author's trilogy on petroleum-production engineering emphasizes the economic aspects of the industry and thus supplements the two earlier texts which deal largely with technologic material. Realizing the current need for engineers who combine technical skill with an appreciation of the economic factors involved in the performance of typical petroleum-engineering problems, the author provides an elementary exposition and interpretation of the basic principles of economic and business administration as they apply specifically to the petroleum-producing industry. Presented from the point of view of the practical engineer, separate chapters provide a varied and comprehensive panel of topics, such as the economic geography of petroleum, oil and gas land acquisition and control, labor management, oil-industry taxation, cost accounting for oil production, and oil and gas conservation.

XUM

DIRECTORY

OF PIPE-LINE CONTRACTORS

. . . who they are . . . where they are . . . officers

Compiled by The Oil and Gas Journal

A. B. C. Construction Co.
14346 Lakewood Boulevard
Los Angeles, Calif.
BARNEY DICKSON, H. W. ANDERSON, and WILLIAM C. BAKER, partners

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M. O. ALTGELT, superintendent

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Associated Pipe Line Contractors, Inc.
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Houston, Tex.
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Atlas Construction Co., Inc.
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FRANK M. MAHAN, president; T. S. MAHAN, vice president; HAROLD E. LEE, secretary-treasurer; H. A. SAYRE, superintendent.

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4108 Old Spanish Trail
Houston, Tex.
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C. P. Bartley & Son
Lance Creek, Wyo.
C. P. BARTLEY and C. P. BARTLEY, JR., partners; G. W. DODSON and NIEL GRANT, foremen.

Looking over the results of the first "Census of Pipe-Line-Contracting Industry" are members of the special field organization created by the Journal several months ago to compile the data: D. B. Miller; J. W. Brownlee; D. W. Wilson; K. B. Barnes, engineering editor; and Paul Reed, pipe-line editor. Highlight information on the Journal's "Pipe-Line Contractors Census" appears on pages 188 and 189 of this issue; the associated "Directory of Pipe-Line Contractors" commences on this page.

Bechtel Corp.
220 Bush Street
San Francisco, Calif.
S. D. BECHTEL, president; W. E. WASTE, J. K. DOOLAN, J. P. YATES, C. S. SNODGRASS, VAN W. ROSENDAHL, vice presidents; G. E. WALLING, treasurer; W. R. AYERS, secretary.

Bechtel-Price-Conyes
(See Bechtel Corp.)

Bills & Troth Construction
428 Wright Building
Tulsa, Okla.
CARL W. BILLS and CLYDE V. TROTH, partners.

Bishop & Lock Construction Co.
503 Magnolia Building
Dallas, Tex.
J. I. BISHOP and L. H. LOCK, partners; HOWARD LAQUEY, superintendent.

F. B. Blank, Contractor
6501 Telephone Road
Houston, Tex.
F. B. BLANK, owner; J. L. McFADDEN, W. R. McFADDEN.

Britton Construction Co.
Weatherford, Tex.
H. R. BRITTON, general superintendent; T. C. PIERCE, superintendent.

Britton Contracting Co., Inc.
93 South Main Street
Washington, Pa.
J. C. BRITTON, ROY CLARK, J. T. FULGHUM.

Brodie Construction Co.
764 North Grand
Amarillo, Tex.
J. T. BRODIE, owner; BILL FENN, superintendent; KENNETH BRODIE, purchasing agent.

Brown & Root, Inc.
4300 Calhoun Road
Houston, Tex.
T. K. MONTGOMERY, equipment superintendent; CLAUDE F. HORTON, manager pipe-line department.

Brown Lite Co.
4107 East Eleventh Street
Tulsa Okla.
H. S. BROWN, Owner.

O. R. Burden Construction Corp.
6702 East Twenty-first Street
Tulsa, Okla.
O. R. BURDEN, president; P. T. THIBODAUX, vice president and general superintendent; J. S. BURDEN, secretary-treasurer; BARNEY HALL and PETE HINER, spread superintendents.

Carruth Pipe Line Corp.
904 Louisiana National Bank Building
Baton Rouge, La.
J. W. CARRUTH, president; W. B. GLOVER and J. PATIU, superintendents.

C. P. Carter Construction Co.
Box 928
Duncan, Oklaho.
C. P. CARTER, president.

Cheek Construction Co.
Ulysses, Kans.
TROY CHEEK, superintendent

Cochran Construction Co.
208-09 Fraser Building
Pampa, Tex.

Contracting and Material Co.
1235 Dodge Avenue
Evanston, Ill.
R. D. CAGNEY, president; E. X. CAGNEY, vice president; J. T. MURRAY, secretary; W. P. CAGNEY, JR., treasurer.

R. A. Conyes Construction Co.
2884 San Pablo Avenue
San Pablo, Calif.
R. A. CONYES, president; MRS. R. A. CONYES, vice president; W. J. WILEY, secretary-treasurer; AL POGG, general superintendent; H. F. KING, office manager in field; JIMMY ALLMAN, superintendent.

Cowan Construction Co.
119 South Hobart
Pampa, Tex.

Geo. W. Davis Construction & Welding Co.
1414 North Eastern
Oklahoma City, Okla.
GEO. W. DAVIS, owner; S. C. THOMAS, assistant superintendent; GEORGE T. DAVIS, business manager.

Deaton & Son
2206 North Grant
Odessa, Tex.
W. F. DEATON, owner.

Douglas Pipe Line Contractors
7804 East Thirty-fourth North
Tulsa, Okla.
A. R. DOUGLAS, manager and owner.

Dumas Pipe Coating Co.
Box 1351
Wichita Falls, Tex.
W. W. TEER, manager partner; L. B. LINGLE, partner.

Carl H. Dunn
1008 Burkburnett Building
Fort Worth, Tex.
CARL H. DUNN, president; HAROLD OWEN mechanic; G. W. COOK, field superintendent.

Eastern Construction Co.
1801 Mercantile Bank Building
Dallas, Tex.
C. HOBSON DUNN, president; J. W. ARTHUR, vice president; F. L. BYERS, superintendent; A. E. ANDERSON, secretary-treasurer; CLIFF SIMMONS and LOUIE STEWART, spread foreman.

L. E. Farley, Inc.
516 Chronicle Building
Houston, Tex.
L. E. FARLEY, president; G. A. ALLMAN, vice president; L. E. FARLEY, JR., secretary-treasurer.

Fish Pipeline Construction Co.
754 M & M Building
Houston, Tex.
O. L. MULLINS, general superintendent of construction; FRANK ISENHART, purchasing agent.

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1221 Baltimore Avenue
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CHAS. S. FOREMAN, president; KENNETH K. KING.

Fowler Construction Co.
Austin, Tex.
GANT FOWLER, owner; N. C. JOHNSON, spreadman.

Frazier Construction Co.
718 West Eighth Street
Odessa, Tex.
G. E. FRAZIER, owner.

Frazier-Davis Construction Co.
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BUDDY SHERROD, general superintendent; JIM WILSON, assistant superintendent; E. H. KERSTING, assistant superintendent.

Vic Fronterhouse
Box 598
Wewoka, Okla.
VIC FRONTERHOUSE, superintendent

R. H. Fulton & Co.
Box 1526
Lubbock, Tex.
R. H. FULTON, owner; CLARK WILLIAMS, general superintendent; A. A. CARRSGAIN, M. L. BOYD, ED VEASH, and JERRY NASH, superintendents.

H. L. Gentry
921 East Michigan Avenue
Jackson, Miss.
H. L. GENTRY, president; J. T. MURRAY, vice president; FRANK MORRIS, superintendent; JIM MITCHELL, foreman.

W. L. Golightly Construction Co.
6427 Pinehurst
Houston, Tex.
W. L. GOLIGHTLY, owner.

Gragg Construction Co.
811 East Britton Avenue
Britton, Okla.
C. H. GRAGG, owner.

Z. Jack Graham
1004 North Taylor
Amarillo, Tex.
Z. JACK GRAHAM, owner; L. A. GILL, superintendent.

G. G. Griffis, Inc.
2514½ East Fifteenth Street
Tulsa, Okla.
G. G. GRIFFIS, president; G. E. MATT, vice president; A. M. GRIFFIS, secretary-treasurer.

Gulf Coast Construction Co.
1920 McCarty
Houston, Tex.
J. J. LEBUFF

Tom Hafer
10000 South Main Street
Houston, Tex.
TOM HAFER, owner.

Luther G. Harper Construction Co.
North Turley, Okla.

A. C. Holder Construction Co.
2615 East Admiral Place
Tulsa, Okla.
A. C. HOLDER, owner; FARIL JOHNSON, superintendent; DWIGHT COWAN, material man.

C. O. Holder Construction Co.
Columbus, Tex.
C. O. HOLDER, owner; C. O. HOLDER, JR., superintendent.

Holland Construction Co.
First National Bank Building
Tulsa, Okla.
H. T. HOLLAND, JR., president; V. M. HOLLAND, vice president; H. M. LAWRENCE, secretary-treasurer; GEORGE WARNER, superintendent.

Hood Construction Co.
3002 East Century Boulevard
Lynwood, Calif.
GEORGE W. HOOD, president; H. E. BROWN, pipe-line construction; J. L. COPELAND, utility construction.

M. L. Hulcher, Inc.
Virden, Ill.
L. H. MORRIS, superintendent; W. H. FLOWERS, spreadman.

Ingram Pipeline Construction Co.
Russell, Kans.
LESTER P. INGRAM and BILLY L. INGRAM, partners.

E. A. Irish, Contractor
2944 Gleneden
Los Angeles, Calif.
WILLIAM E. IRISH, president; CHARLES A. HOAG, vice president.

Jayhawk Construction Co.
Box 68
Great Bend, Kans.
T. L. HICKERSON, president.

Johnston Construction Co.
306 Peoples Federal Building
Wooster, Ohio
B. J. JOHNSTON, JR., superintendent.

Kelly Construction Co.
2215 Belknap Street
San Antonio, Tex.
W. A. KELLY, owner.

K. K. Kennedy Construction Co.
1330 Southeast Twenty-ninth Street
Oklahoma City, Okla.
K. K. KENNEDY, owner.

Knapp Brothers Construction Co.
Box 225
Oxford, Kans.
DONALD D. KNAPP, CHARLES W. KNAPP, and KENNETH C. KNAPP, partners.

Harry C. Knickerbocker, Contractor
Box 2367
Odessa, Tex.
H. C. KNICKERBOCKER, owner; J. W. HUDSON, superintendent.

Knupp Construction Co., Inc.
Box 152
Great Bend, Kans.
HAROLD V. KNUPP, president; ROY E. KNUPP, vice president.

Latex Construction Co.
2707 Ferndale Place
Houston, Tex.
LAURENCE H. FAVROT, president; GEORGE A. PETERKIN, R. P. GREGORY and J. W. SHARMAN, vice presidents.

Lehman, Hoge & Scott
Box 2029
Harlingen, Tex.
ERNIE HILL, superintendent.

Henry L. Lemmons & Co.
Driscoll Building
Corpus Christi, Tex.
W. A. REMMINGTON, superintendent

Lowrie Paving Co., Inc.
1755 Evans
San Francisco, Calif.
RAY KILROY, pipe-line superintendent; WILLIAM BROWN, mechanical superintendent.

Macco Corp.
14409 South Paramount Boulevard
Paramount, Calif.
BARNEY LAUHLERE, division manager; CHARLES SHERMAN and CHARLES COBB, superintendents.

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Hershey Building
Mt. Pleasant, Mich.
E. J. MAHONEY, president; HAROLD FINNERTY, general superintendent; DON MAC DONNELL, purchasing agent; CLIFFORD BEDFORD, secretary-treasurer.

Martin Pipeline & Construction Co.
Box 149
Ulysses, Kans.
R. A. MARTIN, superintendent; N. L. MARTIN, secretary-treasurer.

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Mary Construction Co., Inc.
Cape Girardeau, Mo.
TRECE BOLD, superintendent.

Massey Construction Co.
Box 2029
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OWEN Q. MASSEY, owner.

J. Ray McDermott & Co., Inc.
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G. A. ALLMAN, superintendent; RUBE DODSON, spreadman.

McVean & Roberts
Box 2607
Odessa, Tex.
J. A. McVEAN and A. R. BARLOW, partners; E. J. MILLER, superintendent construction.

John Meehan & Son
916 West Dakota Street
Philadelphia, Pa.
J. T. ELLIS, superintendent.

Mid-States Construction Co.
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Mt. Vernon, Ill.
ROSCOE OVERBY, superintendent

Midwestern Constructors, Inc.
105 North Boulder
Tulsa, Okla.
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Russ Mitchell, Inc.
5304 Old Spanish Trail
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Modern Welding Co.
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817 West Murphy
Odessa, Tex.
M. L. MOORE, owner: M. A. MOORE, foreman.

Morrison Construction Co., Inc.
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Morrison-Knudson Co.
(see Morrison Construction Co., Inc.)

Northeastern Construction Co.
Box 1181
Harrisburg, Pa.
ALVA D. BARTLEY, superintendent.

H. H. Null, Inc.
215 Lockwood
Houston, Tex.
H. H. NULL, owner; MRS. H. H. NULL, vice president; C. E. NULL, spread foreman.

Ohio Pipe Line Construction Co.
1018 Fletcher Trust Building
Indianapolis, Ind.
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1210 Mercantile Bank Building
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2250 East Firestone Boulevard
Los Angeles, Calif.
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Sam B. Pearce
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Los Angeles, Calif.
SAM B. PEARCE, president.

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622 West Murphy
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Houston, Tex.
H. R. HEWITT, owner.

R. B. Potashnick Co.
Box 205
Cape Girardeau, Mo.
R. B. POTASHNICK, owner; W. C. ALLRED.

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3221 Southwest Twenty-ninth Street
Oklahoma City, Okla.
OLEN PRESLEY, owner.

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(see H. C. Price Co.)

H. C. Price Co.
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Reese Brothers Construction Co.
Hugoton, Kans.
PAUL G. REESE, superintendent; C. R. BEIGHLE, office manager; GALE REESE, welding superintendent.

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14433 South Paramount Boulevard
Paramount, Calif.
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3215 North Broadway
Wichita, Kans.
HAROLD RUMSEY; MYRLE RUMSEY; ROBERT RUMSEY; GLENN STITT.

S. E. Pipeline Construction Co.
13736 East Mulberry Drive
Whittier, Calif.
RICHARD S. HENDERSON, president; EVAN N. MANNING, vice president.

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531 Majestic Building
San Antonio, Tex.
N. A. SAIGH, president; N. A. SAIGH, JR., vice president; CARL DOYLE, superintendent; WILLIAM VON PHUL, engineer.

Shanks & Eustace
Box 175
Alice, Tex.
H. S. SHANKS and B. C EUSTACE, partners.

Sheehan Pipe Line Construction Co.
529 National Bank of Tulsa Building
Tulsa, Okla.
ROBERT D. SHEEHAN and JAMES H. NOLAN, general superintendents; JOHN B. SHEEHAN, general manager; C. M. BROWN and J. W. BROWN, field superintendents.

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Corpus Christi, Tex.
FRED WAKEFIELD, superintendent.

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O. R. SMITH, president; MARY ELDER, secretary; ARNOLD SMITH, general superintendent; CHARLES C. CRAIG, superintendent.

Ray L. Smith & Son, Inc.
226 West Central Avenue
El Dorado, Kans.
RAY L. SMITH, president; RAY LEIGH SMITH, vice president and treasurer; WILLIAM G. FROST and DON C. SMITH, spread superintendents.

Somerville Construction Co.
Ada, Mich.
ROBERT B. SOMERVILLE

Delmer M. Spafford
Farmington, N. M.
DELMER M. SPAFFORD, owner; M. G. HURD, spread man.

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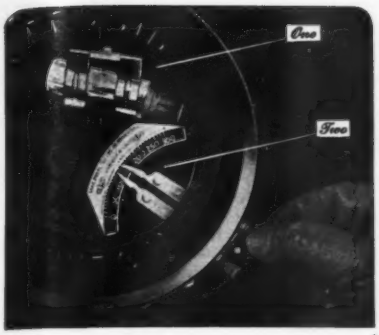
7812 Avenue I
Houston, Tex.
J. R. STEWART, president; MRS. J. R. STEWART, vice president; E. L. PUMPHERY, shop superintendent.

Submarine Pipe Line Construction Co.
Port Lavaca, Tex.
W. H. BAUER, president; H. C. SMITH, vice president; SAMMY COLLINS, superintendent.

T. & R. Construction Co.
Route 10, Box 45
Houston, Tex.
D. W. ROSS, president; ELVIN MORRIS, equipment superintendent; MELVIN LACY, vice president.



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Two *The simple, accurate and positive means of making necessary operating adjustments. No loss of time or annoying guesswork.*

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THOMPSON-CARR INC.
ODESSA, TEXAS
June 5, 1950

Mr. Ben O. Morgan, Mgr.
General Machine & Supply Co.
Box 5907
Dallas, Texas

Dear Sir:

This year marks the 11th year since we purchased our first LeRoi engines from you, and I thought perhaps you would like to know how we feel about the service we have received from these engines and also the service your company has given us then.

I can tell you honestly that these engines have given us better service than any engines we have ever owned or operated. As you know, we recently purchased from you two more of the 12 cylinder engines and they were installed on a new rig and are being operated in the Snyder area. At the present time we are operating 27 of these 12 cylinder engines, 2 of the 8 cylinder engines and 4 of the 6 cylinder engines. We are also operating 50 of the smaller engines and Generating Plants of various sizes. All of these engines have given us excellent service. The prompt and efficient service which your company has given on these engines makes them even better and more economical to operate

Therefore, I can tell you that we think that LeRoi engines and General Machine & Supply Co. make the best combination for the oil fields. After operating LeRoi engines for 11 years, I do not hesitate in recommending them as the most economical power for the oil fields. I also wish to say that we will look to LeRoi and General Machine & Supply Co. for our future requirements.

Yours very truly,
THOMPSON-CARR, INC.
Fred Forster
Vice President

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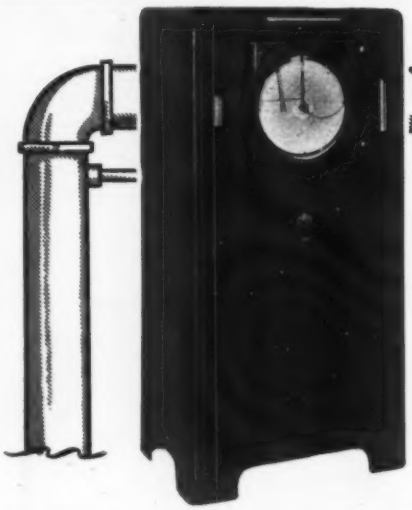

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Computing Size of Tanks

(Continued from page 217)

13. Determine allowance for arrival of heater oil No. 1 at Terminal "X" on nonshipping days (week ends):

2 days × 2,400 bbl. per day = 4,800 bbl.

14. Add calculated volumes to determine total working tank volume required for heater oil No. 1 at Terminal "X":

Item	Bbl.
9. Quantity required between tenders	24,000
11. Allowance for undershipments*	18,000
12. Allowance for overshipments†	8,000
13. Allowance for nonshipping days	4,800
Total working volume required (excluding outage allowances)	54,800
15. Allowance for tops and bottoms cone-roof tank 80 ft. in diameter	2,700
Total calculated volume required	57,500
Tank size recommended (cone roof 80 ft. by 64 ft. nearest standard size tanks—96-in. courses)	57,000

***Undershipments.**—Since product for overshipments is usually in the tank, additional tank volume must be provided for undershipments.

Once a product tender is pumped into a pipe line, each terminal must have sufficient tank space available to hold its proportional share of the total tender in the event of bad weather, reduced demand, inability to ship, strikes, etc. Operating under this principle avoids a line shutdown during localized adverse conditions which would disrupt receipt of needed stocks at terminals operating under normal conditions.

Since demand for most products is seasonal, terminal storage space for undershipments can also be utilized during offseason by predelivering products, thus leveling out the pipeline operations.

Storage space allowed for undershipments can be omitted from tankage calculations if a terminal is located near the refinery or source of supply. This is possible because the total tender could either be proportionately reduced before the product was pumped into the line or if terminals further along the line had available storage space, the product tender scheduled for the near terminal could be delivered where storage space is available.

†**Overshipments.**—Terminals usually overship during certain periods of the month, which might be caused by threatened strike, unfavorable weather forecasts, upward price adjustments, etc.

Development of Tankage Formula

Symbols to be used are as follows:

V_t = maximum monthly volume of the product to be shipped from terminal in barrels.

V_p = total monthly volume of the product to be pumped through the pipe line immediately upstream from terminal in barrels.

V_L = total monthly volume of all products to be pumped through the pipe line immediately upstream from terminal in barrels.

n = normal number of tenders of the product to be pumped during each month.

$R = V_p/V_L$ portion of month the terminal will receive the product.

Q_1 = quantity required between tenders.

Q_2 = quantity required for undershipments.

Q_3 = quantity required for overshipments.

Q_4 = quantity required for week-end arrival of product.

T = total working tank volume required (excluding tops and bottoms).

1. Formula for Normal Terminal

T = quantity required between tenders, plus one-half maximum tender (undershipments), plus one-third quantity required between tenders (overshipments), plus quantity shipped in 2 days (week-end arrival).

$$T = Q_1 + Q_2 + Q_3 + Q_4.$$

Q_1 = maximum monthly volume of the product to be shipped from terminal minus quantity shipped from tank while receiving product, divided by the normal number of tenders of the product to be pumped. Quantity shipped from tank while receiving product:

$$= \frac{V_t}{30}(V_p/V_L \times 30)$$

$$= V_t \times V_p/V_L \text{ (combination of Steps 5, 6, and 7)}$$

$$Q_1 = \frac{V_t - (V_t \times V_p/V_L)}{n}$$

$$= \frac{V_t}{n} - \frac{V_t}{n} \times \frac{V_p}{V_L}$$

$$= \frac{V_t}{n}(1 - V_p/V_L) = \frac{V_t}{n}(1 - R)$$

Q_2 = ½ of maximum tender (undershipments)

$$= \tfrac{1}{2}\frac{V_t}{n} = \frac{V_t}{2n}$$

Q_3 = ⅓ quantity required between tenders (overshipments)

$$= \tfrac{1}{3}\,Q_1 = \frac{1}{3}\frac{V_t}{n}(1 - R)$$

$$= \frac{V_t}{3n}(1 - R)$$

Q_4 = quantity shipped in 2 days (week-end arrival)

$$= V_t/30 \times 2 = V_t/15$$

Since:

$$T = Q_1 + Q_2 + Q_3 + Q_4$$

Then:

$$T = \frac{V_t}{n}(1 - R) + \frac{V_t}{2n} + \frac{V_t}{3n}(1 - R) + \frac{V_t}{15}$$

$$= \frac{V_t}{n}(1 - R + 1/2 + 1/3 - R/3) + V_t/15$$

$$T = \frac{V_t}{n}(11/6) - 4R/3) + \frac{V_t}{15}$$

2. Formula for Terminal Located Near Refinery or Source of Supply

As previously mentioned, the storage space allowed for **undershipments**

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can be omitted from tankage calculations. The formula then becomes:

$$T = Q_1 + Q_3 + Q_4$$

$$= \frac{V_t}{n}(1 - R) + \frac{V_t}{3n}(1 - R) + \frac{V_t}{15}$$

$$T = \frac{4\,V_t}{3n}(1 - R) + \frac{V_t}{15}$$

Note: Formulas for T are not factored further because graphs are plotted with V_t/n as abscissa.

To illustrate the formula for calculating a tank size for a normal terminal, the same quantities used in the previous example are substituted in the formula.

$V_t = 72{,}000$

$n = 2$

$$R = \frac{300{,}000}{900{,}000}$$

Formula:

$$T = \frac{V_t}{n}(11/6 - 4R/3) + \frac{V_t}{15}$$

$$T = \frac{72{,}000}{2}\left(\frac{11}{6} - \frac{4}{3} \times \frac{300{,}000}{900{,}000}\right) + \frac{72{,}000}{15}$$

$$T = 36{,}000\left(1.8333 - \frac{400{,}000}{900{,}000}\right) + 4{,}800$$

$$T = 36{,}000\,(1.8333 - 0.4444) + 4{,}800$$

$T = 50{,}000 + 4{,}800$

$T = 54{,}800$ exclusive of outages (tops and bottoms)

Tank size then can be selected as shown in initial example.

Determination of Tank Size by Graph

To represent the tankage formula graphically, it is necessary to omit allowance for the 2 nonshipping days for week-end arrival of product. This amount must be added to the volume determined from the graph in order to select proper tank size exclusive of outages (tops and bottoms). Graphs are constructed using the maximum tender as abscissa and tank volume required as ordinate with a series of curves representing the portion of time the terminal will receive the product. (Stepwise method of developing graphs can be found at the end of this article.)

Tankage requirements for normal pipe-line terminals can be obtained from Graph 1, and tankage requirements for terminals near refinery, or source of supply, can be obtained from Graph 2.

Tank size is selected by graphical method by determining (1) the maximum tender V_t/n and (2) the portion of the month terminal receives the product $V_t/V_L = R$. Using previous example:

$$\frac{V_t}{n} = \frac{72{,}000}{2} = 36{,}000$$

$$R = \frac{V_p}{V_L} = \frac{300{,}000}{900{,}000} = 0.333$$

Read across bottom of Graph 1, "Maximum Tender Size," to 36,000 and then vertically to intersect a line where R equals 0.333; thence, from this point of intersection horizontally across graph to read volume as 50,000 bbl. Since the graph does not include the 2 nonshipping days, we must add 4,800 bbl. to determine volume to be 54,800 bbl. (exclusive of outages). Tank size then can be selected as shown in initial example.

The size tank, as determined by any of these methods, will adequately handle volumes for all months regardless of seasonal changes. In these calculations, terminals close to refinery or source of supply are those not farther than 2 or 3 pumping days away from such source.

In most cases, normal increases of shipments from terminals which may occur in later years can be handled in tank constructed. However, if abnormally large increases occur, it is possible to handle such volume by increasing the number of tenders of the product through the line.

In calculating tank sizes, full consideration should be given to provide adequate flexibility, because product pipe lines are not normally operated on a uniform pumping schedule, and tank space must be available for products once they are pumped into the pipe line. In the writer's opinion, the method presented in this article meets these requirements.

Preparation of Charts

In the preparation of graphs for tankage, using the method outlined here, the procedure and requirements are:

1. Assume maximum tender of 100,000 bbl.
2. Find tankage required by substituting various values of R (portion of month terminal receives stock) in tankage formula.
3. Plot values determined in (2) on 100,000-bbl. ordinate.
4. Draw lines from points plotted in (3) to the original point of the abscissa and ordinate axes.

Large-Clearance Compressor Cylinders

(Continued from page 224)

zontal Cooper-Bessemer units have been converted to the large-clearance cylinder. In these installations the cylinder diameter was changed from 13½ to 15½ in., using special clearance pistons, special clearance caps on discharge valves, and special clearance pocket loaders on suction valve caps.

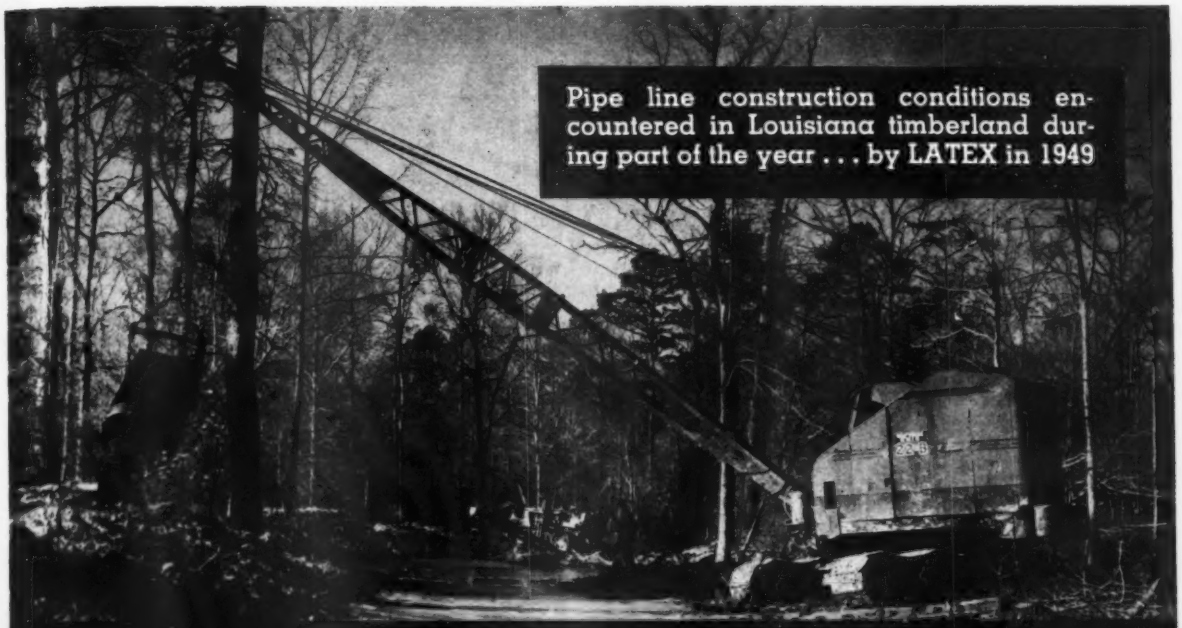
Fig. 8 shows the comparison of the load curve with the 15½-in. liners to the load curve with the 13½-in. liners. Full load cannot be maintained from a 1.42 compression through a 2.7. At present the predicted ratios of compression for the three stations having this type equipment are within the range of 1.4. Had the 13½-in. liners been left in the cylinders, the horsepower of the station would have had to be derated by approximately 16 per cent when operating on the 1.4 compression. With the converted cylinders 97½ per cent full load on the 1.4 ratio of compression can be maintained.

It has been possible to improve the load curve on the original BA-6 and BA-8 Clark engines through an exchange of cylinders. The BA-8 units, as originally installed, were equipped with four 8¾-in. cylinders which did not load the units at the lower ratios. These cylinders are being replaced with new 10½-in. cylinders ordered with new HBA-6 units. Fig. 10 shows the load curve on these new cylinders.

The 8¾-in. cylinders removed from the BA-8 units are being reequipped with double-deck valves and reinstalled on the BA-6 units. The liner diameter is being changed to 9½-in. when used on the HBA-6 units.

Prior to the adoption of the large-diameter, large-clearance cylinder to T.G.T.'s system, a number of tests were conducted with the Cooper-Bessemer's balanced pressure indicator on various types of cylinders to determine operating efficiency of the equipment. These tests pointed out necessity of large pipe connections, greater valve area, and adequate gas passages to prevent excessive waste of horsepower within the cylinder. At present T.G.T. is insisting that the inlet and discharge connections to cylinders be as large as practicable—at least 8 in. Compressor valves have been increased from 6-in. to as much as 7¾-in. diameter, with as many valves as possible being used in the compressor cylinder. The double-deck-type valve, giving still greater valve area, is being used in a number of cylinders.

The problem of operating equipment in ratios of pressure below 2, and the advantages of large valve area and large clearance was recognized as early as 1937 by H. C. Lehn, Worthington Pump & Machinery Co. In his paper, "Recent Developments in Gas-Compressing Machinery," presented at the Natural Gas Association convention in 1937, Lehn said: "For pipe-line service the best compressor design demands maximum possible valve area. In the early days when compression ratios varied from 3 to 6, large valve area was not extremely important. At the present time compression ratios above 2 are infrequent and may be as low as 1.25. Under



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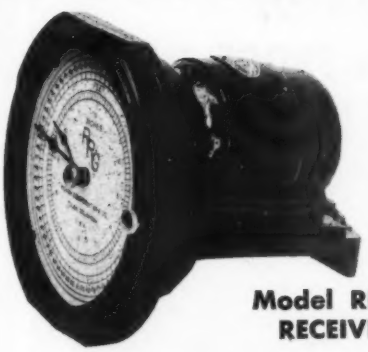

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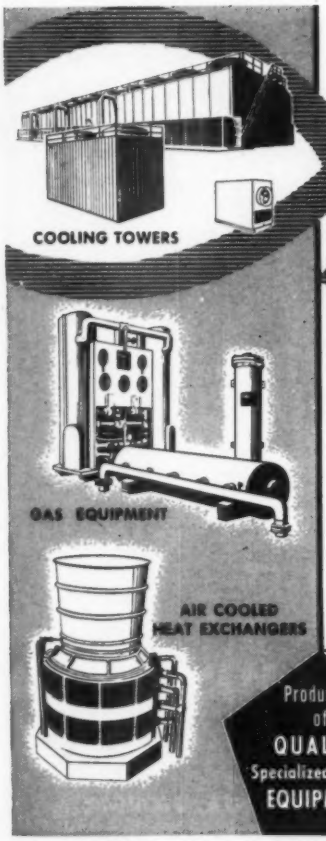

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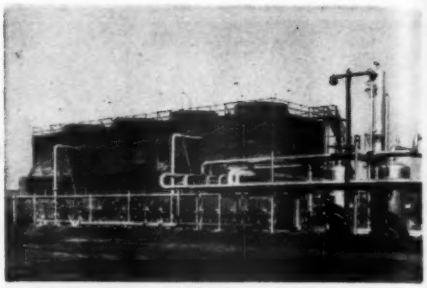

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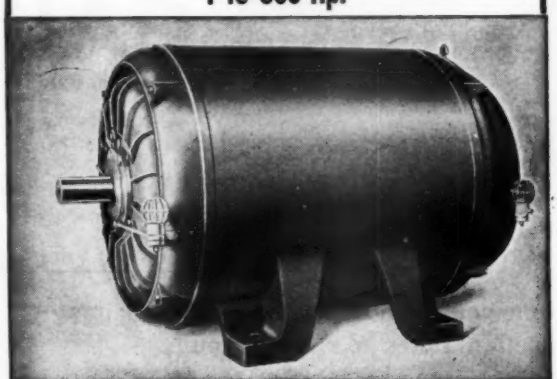

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these conditions the effect of valve friction on the compressor efficiency is greatly increased. Again, for some time high volumetric efficiency was considered desirable. This is obtained only by a low clearance volume not compatible with large valve area. The results obtained from the deliberate introduction of clearance by the use of unloaders, which is now common, has shown that high volumetric efficiency is of no particular importance and should not be obtained at the expense of valve area.

"Clearance unloaders are now in extensive use and, under conditions quite frequently met, greatly increase the capacity and flexibility of the unit."

The thoughts expressed were certainly timely. It is unfortunate, however, that there apparently was no practical application made of the full use of large-clearance cylinders with large valve areas until within the last few years.

Compressor-Station Design

(Continued from page 228)

lower efficiency to be expected for any operation other than the design conditions. Because of this fundamental feature the units are not very flexible and preferably should be installed in main trunk-line systems with high capacity factor for efficient operation.

Gas turbines are now under design and being manufactured for gas-pipeline operation. Only experience will show if the gas-turbine, centrifugal-compressor unit will be favorable from a total operating and fixed-charge standpoint when compared with the conventional gas-engine station. For certain duties it may supersede the reciprocating engine where the actual operating conditions correspond closely with design conditions.

Piping Design

With the advent of long-distance high-pressure gas-transmission pipe lines it has been necessary to make corresponding progress in piping design.

A new device, the electric strain gage developed during World War II, is now being used to measure strain on the surface of a member subjected to stress. The measured stress in psi. obtained experimentally by this instrument probably is more accurate and reliable than theoretical stresses from complex design calculations. Recently, strain-gage equipment was used to test some large-diameter pipe fittings to be installed for operating pressures of 900 psi. The results of these tests showed that certain type fittings were suitable for installation while others required reinforcement at critical points to meet requirements of the Code for Pressure Piping. Fig. 4 shows the strain gage in place on a welded tee fitting.

Pipe Vibration

With the increase in operating pressures the problem of vibration in discharge piping has presented troublesome and hazardous conditions. Fortunately the solution has not been too difficult. It was found that pipe vibration is due primarily to surging flow caused by pressure pulsations, and not from vibration from the engines and compressors. The proper sizing of piping and the installation of special dampening equipment will minimize this trouble. Such dampening equipment consists, essentially, of a reservoir installation designed to reduce the high instantaneous gas velocities from the compressors.

Station Vibration Control

In addition to pipe vibration from gas flow, general station vibration is often experienced at plants where a large number of horizontal compressor units are installed. This vibration, which is parallel to the movement of the heavy reciprocating members of the units, appears as a general lateral movement of the main building floor, engine foundations, and general station area.

Studies of such vibration show that it increases or decreases in intensity

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depending upon the angular crank relationship among the different engines. When the cranks operate together the vibration is maximum and when the cranks are out of phase the vibration is minimum. Using this information, a mechanical control system was designed and installed a number of years ago in a main-line station of Cities Service Gas Co. to maintain the desired phase relationship.

This system comprises a controlling differential gear assembly connected to a layshaft of each engine, and interconnected through a common control shaft to all engines. One engine is controlled by its regular speed governor and drives the control shaft. The differential at each engine is connected in a position so that the cranks of adjacent engines are at 180° relationship. By means of a lever attached to the throttle bar, all engines are made to operate at identical speeds and at the desired crank relationship. This system has operated very satisfactorily over a period of approximately 8 years.

Cooling Systems

During the past several years there has been a trend to the utilization of aerial-type gas and water-cooling equipment for compressor stations. The advantage of this type equipment is that practically all makeup water requirements for the station are eliminated. In operation of this equipment the heat is dissipated into the air from finned cooling surfaces. Electric motor or engine-driven fans are used to move large volumes of air around the finned tubes. This type of cooling equipment is fundamentally similar to an automobile radiator. Undoubtedly, the efficiency and low maintenance costs of the aerial-type coolers for water and gas are responsible for much of their popularity. Fig. 5 shows a typical aerial-type gas and water-cooling installation.

Water Softeners

Another new development in water systems for gas compressor stations is the demineralizing water-softening plant. In this type water treater all of the minerals are removed from the water making it comparable in physical properties to steam condensate. This process is fundamentally different from the two basic types used formerly, that is, lime precipitation and zeolite exchange equipment.

Code for Pressure Piping

Section 2, Gas and Air Piping, Code for Pressure Piping, A.S.A. B31.1-1942 is now being revised to clarify and reflect recent improvements and developments in design for compressor station piping.

This revision is scheduled for publication the latter part of 1950, and will serve as a reliable guide for design engineers in the gas industry.

Pipe-Line Construction

FOLLOWING is a tabulation of pipeline projects which are planned or under construction. Included are crude-oil, products, and natural-gas lines. The list was compiled from surveys made by The Oil and Gas Journal.

Crude-Oil Pipe Lines

Gulf Refining Co., Tulsa Pipe Line Division.—72 miles, 6-in., under way, El Dorado, Kans., to Webb City, Okla.; Pipeline Service Co., contractor. J. W. Welcher, Atlanta, Kans., spreadman.

Lakehead Pipe Line Co., Inc. (American subsidiary of Interprovincial Pipe Line Co., Canada).—321 miles, 18-in., contracted Neche, N. D., to Superior, Wis., to be completed October 1950; Anderson Bros., contractor.

Pan American Pipe Line Co.—80 miles, 10-in., under way, from southern part of Scurry County, Texas, to a connection with Humble pipe line near San Angelo, Tex.; Brown & Root, contractor.

Pelican Oil Co.—60 miles, 6-in., under way, Lake Charles to DeQuincy, La.

Phillips Pipe Line Co.—50 miles, 6-8-in., under way, Phillips tank farm, Sweeny, Tex., to Humble's Webster Station, Galveston County, Texas; O. R. Burden Construction Co., contractor; B. C. Barney Hall, spreadman.

Phillips Pipe Line Co.—25 miles, 8-in., considered, loops between Thrall and Kansas City, Kans.

Platte Pipe Line Co.—1,080 miles, 16-20-in., planned, Worland, Wyo., to Wood River refining area in Illinois.

Platte Pipe Line Co.—940 miles, 20-in., planned, Casper to Wood River.

Platte Pipe Line Co.—140 miles, 16-in., planned, Worland to Casper, Wyo.

Portland Pipe Line Co. (Montreal Pipe Line Co., Ltd.).—236 miles, 18-in., contracted, Portland, Me., to Montreal, Que., Canada.

Portland Pipe Line Co. (Montreal Pipe Line Co., Ltd.).—85 miles, 18-in., under way, Portland, Me., to Gorham, N. H.; Oklahoma Contracting Co., contractor of Section 1; H. A. Waylie, Westbrook, Me., superintendent.

Portland Pipe Line Co. (Montreal Pipe (Canada).—321 miles, 18-in., contracted, Gorham, N. H., to international boundary near N. Troy, Vt.; Associated Pipeline Contractors, Inc., contractor of Section 2. Lacy Walker, Barton, Vt., spreadman.

Portland Pipe Line Co. (Montreal Pipe Line Co.).—68 miles, 18-in., contracted, Canadian boundary to Montreal; Fred Mannix, contractor of Section 3.

Service Pipe Line Co.—25 miles, 8-in., under way, Beaver Creek and Riverton, Wyo.; Vaughn & Taylor Construction Co.

Shell Pipe Line Corp.—39 miles, 10-in., under way, McCamey to Kemper, Tex.; McVean & Roberts, contractor.

Socony-Vacuum Oil Co., Inc. (White Eagle Division).—122 miles, 8-in., considered, Big Horn basin to Casper, Wyo.

Texas-New Mexico Pipe Line Co.—16½ miles, 10-in., under way, Scurry County, Texas; O. R. Burden, contractor, Bill Price, spreadman.

West Coast Pipe Line Co.—20-in., planned, Permian basin, West Texas, to California.

Products Pipe Lines

Great Lakes Pipe Line Co.—39 miles, 12-in., under way, Hawarden, Iowa, to Sioux Falls, S. D.; Midwestern Constructors, Inc., contractor, R. C. Stanley, Canton, S. D.

Great Lakes Pipe Line Co.—355 miles, 12-in., authorized, Kansas City through Omaha and Sioux City, Iowa, to Sioux Falls, S. D.

Phillips Petroleum Co.—281 miles, 10-in., proposed, Borger, Tex., to Yale, Okla.

Phillips Petroleum Co. and Shamrock Oil & Gas Co.—155 miles, 6-in., planned, extension on 600-mile line at Phillips, Tex., via La Junta, to Denver.

Pure Transportation Co.—100 miles, 6-in., proposed, Heath to Dayton, Ohio.

Salt Lake Pipe Line Co.—242 miles, 6-8-in., under way, Boise, Idaho, to Pasco, Wash. Completion date, December 1950.

Salt Lake Pipe Line Co.—140 miles, 8-in., contracted Boise, to Baker, Idaho; Bechtel Corp., contractor.

Salt Lake Pipe Line Co.—Contracted, Macco Corp., and Morrison-Knudson Co., Inc.

Salt Lake Pipe Line Co.—120 miles, 6-8-in., under way, Baker, Ore., to Pasco, Wash. Completed August 8, 1950; Pacific Pipeline & Engineers, Ltd., contractor, L. E. Robertson, LaGrande, Ore., spreadman.

Standard Oil Co. (Ohio) and Shell Oil Co.—56 miles, 8-in., under way, Lima to Springfield, Ohio; Tulsa Construction Co., contractor.

Susquehanna Pipe Line Co.—126 miles, 8⅝-in., under way, Toledo, Ohio, to Sarnia, Ont., Canada; H. L. Gentry Construction Co., contractor. James Mitchell, Toledo, Ohio, spreadman.

Natural-Gas Pipe Lines

Acme Natural Gas Co.—25½ miles, 6-10-in., contracted, Ellwood to Butler, Pa., to be completed December 1, 1950; Williams-Austin Co., contractor. Leman Creech, Zelienople, Pa., spreadman.

Alabama-Tennessee Natural Gas Co.—35 miles, 8-in., authorized, Muscle Shoals to Decatur, Ala.

Algonquin Gas Transmission Co.—276 miles, proposed, Lambertville, N. J., to Boston area.

Algonquin Gas Transmission Co.—492 miles, proposed, laterals, New England area.

Atlantic Gulf Gas Co. (United Gas Pipe Line Co.).—1,530 miles, planned, Alabama-Florida-Georgia-South Carolina.

Central Kentucky Natural Gas Co.—42 miles, 20-in., under way, North Means compressor station to Foster, Ky; completion date December 1, 1950; Williams-Austin Co., contractor, Howard Bauer, Mt. Sterling, Ky., spreadman.

Chicago District Pipe Line Co.—41 miles, 24-in., authorized, loop Calumet pipe line—Joliet, Ill., to Chicago, completion date December 1950.

City of Indianapolis, Inc.—55 miles, 16-in., proposed, Indianapolis to Texas Eastern Transmission Corp. system.

Coast Counties Gas & Electric Co.—40 miles, 3-4-8-in., considered, coast and valley region, California.

Coastal Pipe Line Co.—1,000 miles, planned, Texas to Norfolk, Va.

Commonwealth Natural Gas Corp.—84 miles, 12-in., contracted, Richmond to Newport News, Va.; Ray L. Smith, contractor.

Commonwealth Natural Gas Co.—20 miles, 8-in., contracted, James River to Newport News, Va.; Ray L. Smith, contractor.

Commonwealth Natural Gas Co.—10 miles, contracted, laterals, Richmond, Suffolk, and Portsmouth, Va.; Ray L. Smith, contractor.

Commonwealth Natural Gas Corp.—104 miles, 18-in., under way, Standardsville to near Petersburg, Va.; Ray L. Smith & Son, contractor, Don C. Smith, Orange, Va., spreadman.

Commonwealth Natural Gas Corp.—537 miles, 20-in., proposed, West Bend, Ky., to Norfolk, Va.

Consolidated Gas Utilities Corp.—41 miles, 12-in., planned, Enid to Blackwell, Okla., Marlow to Cement, Okla.

East Ohio Gas Co.—24 miles, 20-in., authorized, northeastern Ohio to near Petersburg to East Ohio's Austintown station near Youngstown.

East Tennessee Natural Gas Co.—100 miles, planned, lateral to be laid in 1950.

East Tennessee Gas Corp.—150 miles, 16-

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in., under way, Knoxville to Bristol, Tenn.

East Tennessee Natural Gas Co.—398 miles, 3-16-in.. planned, Nashville to Chattanooga to Knoxville, Tenn., and laterals.

East Tennessee Natural Gas Co.—106 miles, 12-16-in.. contracted, Lobelville to Tullahoma, Tenn.; Oman Construction Co., contractor.

East Tennessee Natural Gas Co.—130 miles, 12-in., under way, Athens, via Chattanooga, to Tullahoma, Tenn.; N. A. Saigh Co., Inc.

East Tennessee Natural Gas Co.—120 miles, 12-in., planned, Chattanooga to Knoxville, Tenn.; Walters & Saigh Construction Co.

East Tennessee Natural Gas Co.—185 miles, 16-in., planned, Lobelville to Chattanooga, Tenn., Walters & Saigh Construction Co.

Eastern Natural Gas Corp.—292 miles, 24-in., proposed, Phoenixville, Pa., via New Haven and Hartford, Conn., Providence, R. I., Springfield, Mass., and Boston.

Egyptian Natural Gas Co.—80 miles, 6-8-in., planned, Norris City to Salem-Centralia, Ill.. area.

El Paso Natural Gas Co.—352 miles, 30-in., under way, looping of 26-in., New Mexico-California line and connection with Pacific Gas & Electric Co. at Needles, Calif., to be completed November 1950.

El Paso Natural Gas Co.—450 miles, 24-in., authorized, San Juan basin, New Mexico, to Franconia, Ariz., to be completed November 1951 by company crews.

Home Gas Co.—70 miles, planned, Orange, Sullivan, Rockland, and Cattaraugus counties, New York.

Jersey Central Power & Light Co.—39 miles, 10-in.. planned, New Jersey coast system of Texas Eastern Transmission Co.'s Big Inch.

Magnolia Petroleum Co.—60 miles, 4-24-in., gathering system in LaWard and Lolita fields, Texas; Henry L. Lemons & Co., contractor. W. A. Remington, spreadman.

Michigan Gas Storage Co.—150 miles, 20-in., planned, Chelsea terminal-Winterfield and Cranberry Lake, Mich.; Mahoney Contracting Co., contractor.

Michigan-Wisconsin Pipe Line Co.—197 miles, 6-18-in., under way, Milwaukee to Green Bay and Two Rivers, Wis.; G. G. Griffis Construction Co., contractor. F. K. Egan, Fond du Lac, Wis.

Mississippi River Fuel Corp.—40 miles, 18-in., authorized, Dubach to Perryville, La.

Montana-Dakota Utilities Co. and Montana-Wyoming Gas Pipe Line Co.—335 miles, 12¾-in., under way, Worland, Wyo., to Baker, Mont.; R. A. Conyes Construction Corp., contractor. Al Poggi, Hardin, Mont., superintendent.

New York State Natural Gas Corp.—21 miles, 20-in., under way, Tonkin station to Bakerstown, Pa.. to be completed December 1, 1950; Williams-Austin Co., contractor. Ralph Gaddy, New Kensington, Pa., spreadman.

New York State Natural.—164 miles, 16-in., planned. Ithaca to Albany, N. Y.

New York State Natural Gas Corp.—70 miles, 20-in., planned, North Oakford, Pa., to Ohio state line.

Niagara Mohawk Power Corp.—35½ miles, 10-14-in., under way, Therm station, to Fulton, N. Y.; Williams-Austin Co., contractor. Howard Bauer, Nedrow, N. Y., spreadman.

Northeastern Gas Transmission Co.—511 miles, up to 20-in., proposed, to extend from a connection with a proposed Tennessee Gas Transmission Co. extension to serve New England states.

Northern Natural Gas Co.—597 miles, 20-26-in., contracted, ten loops from Texas to northern Iowa.

Northern Natural Gas Co.—6 miles, 4 to 12-in., under way, gathering line in vicinity of Hugoton, Kans., Cheek Construction Co., contractor, Troy Cheek, Ulysses, Kans., superintendent.

Northern Natural Gas Co.—111 miles, 24-in., under way, Ogden, Iowa, to St. Paul, Minn.; R. B. Potashnick, contractor.

Northern Natural Gas Co.—75 miles, 26-in., under way, north of Beaver, Okla.; R. H. Fulton & Co., contractor of Loop 2. Merele Lewellen, Mead, Kans., spreadman.

Northern Natural Gas Co.—33 miles, 26-in., contracted, Mullinville, Kans., station; R. H. Fulton & Co., contractor of Loop 3.

Northern Natural Gas Co.—72½ miles, 26-in., under way, Bushton to Minneapolis, Kans.; R. H. Fulton & Co., contractor of Loop 4. M. L. Boyd, Salina, Kans., spreadman.

Northern Natural Gas Co.—155 miles, 20-in., contracted, Garden City to Bushton, Kans.; R. H. Fulton & Co., contractor of Loop 5. Jerry Nash, Garden City, Kans., spreadman.

Northern Natural Gas Co.—43 miles, 26-in., under way, Palmyra, Neb., station to Oakland, Iowa, station; Midwestern Construction Co., Inc., contractor of Loop 6. R C. Stanley, Glenwood, Iowa, spreadman.

Northern Natural Gas Co.—65 miles, 26-in., under way, northeastward from Oakland, Iowa, station; Midwestern Construction. Inc., contractor of Loop 7. Lyle S. DeWitt, Palmyra, Neb., and J. A. Bard, Beatrice, Neb., superintendent.

Northern Natural Gas Co.—31 miles, 26-in., under way, north of Ogden, Iowa; R. B. Potashnick Co., contractor of Loop 8. H. F. Carr, Ventura, Iowa, spreadman.

Northern Natural Gas Co.—41 miles, 26-in., contracted, northward from Ventura, Iowa, station; R. B. Potashnick Co., contractor of Loop 9.

Northern Natural Gas Co.—40 miles, 26-in., contracted, Ventura, Iowa, station; R. B. Potashnick, contractor of Loop 10.

Northern Natural Gas Co.—222 miles, 26-in., under way, Borger, Tex., to Nebraska line; R. H. Fulton & Co., contractor. M. C. Boyd, Ashland, Kans., spreadman.

Northwest Natural Gas Co.—750 miles, planned, Washington, Oregon, and Idaho.

Ohio Fuel Gas Co.—22 miles, 16-in., authorized, Dayton, Troy, Piqua, and Sidney, Ohio.

Pacific Gas & Electric Co.—47 miles, 8-in., authorized, Salinas to Kilig City, Calif.

Pacific Gas & Electric Co.—426 miles, 34-in., under way, Topock, Ariz., to Llanda, Calif.; Bechtel-Price-Conyes Corp., contractor. R. L. Bowman, general superintendent.

Pacific Lighting Corp.—23 miles, 30-in., planned, Inglewood to Encino, Calif.

Pacific Lighting Corp.—41 miles, 30-in., planned, Puente to March Field, California, to be completed 1950.

Pacific Northwest Pipe Line Co.—400 miles, 22-in., gathering lines on Texas Gulf Coast to Pacific Northwest pipe line.

Pacific Northwest Pipe Line Corp.—2,175 miles, 26-in., authorized, Texas Gulf Coast to Pacific Northwest.

Panhandle Eastern Pipe Line Co.—356 miles, 26-in., authorized, looping in Texas, Oklahoma, Kansas, Missouri, Illinois, Indiana, Ohio, and Michigan.

Phillips Petroleum Co.—118 miles, 3-22-in., under way, Sherman and Hansford counties, Texas, gas-gathering system; Vaughn & Taylor Construction Co., Inc., Texhoma, Okla.

Piedmont Natural Gas Co.—1,350 miles, 20-in., planned, Greenville, Miss., to Carolinas.

Plains Natural Gas Co.—200 miles, 4-24-in., contracted, Oklahoma-Kansas area, Hugoton field, gathering system; Midwestern Constructors, Inc., (Arey-Phillips Construction Co.) contractor. T. S. Nunley, Liberal, Kans., spreadman.

Potomac Gas Co.—18 miles, 16-in., planned, Dranesville to Arlington, Va.

Prince George's Gas Corp.—20 miles, 22-in., authorized between Chillum and Rockville, Md.

Roanoke Pipe Line Co.—30 miles, 8-in., authorized, Gala, Va., to Roanoke.

San Diego Gas & Electric Co.—53 miles, 16-in., planned, San Diego County, California.

San Diego Gas & Electric Corp. (Southern Counties Gas Co.)—85 miles, authorized, San Diego, Riverside, and Moreno, California.

South Central Alabama Natural Gas Co., Inc.—150 miles, proposed, central Alabama.

South Georgia Natural Gas Co.—248 miles, planned.

South Jersey Gas Co.—75 miles, 10-12-14-in., under way, Pleasantville, N. J., to Bustleton, Pa.; G. G. Griffis, Inc., contractor, Ray Abney, Millville, N. J., spreadman.

South Jersey Gas Co.—14-in., under way, Franklinville to Bridgeton, N. J.; G. G. Griffis, Inc., contractor.

Southwestern Michigan Gas Co.—55 miles, 12¾-in., proposed, Oakland County to Marysville, Mich.

Southern California Gas Co.—83 miles, 30-in., under way, Whitewater, Riverside County, to Puente, Los Angeles County, California; Midwestern Constructors, joint contract with Johnson Western Gunite—L. E. Dixon. John Work, Banning, Calif., superintendent.

Southern Counties Gas Co. of California.—81 miles, 20-in., authorized, looping.

Southern Natural Gas Co.—32 miles, 16-in., under way, Wetumpka to Tallassee, Ala.; completion due November 1; Sheehan Pipe Line Construction Co., contractor, C. M. Brown, spreadman.

Southern Natural Gas Co.—180 miles, 18-in., under way, Gwinville, Miss., to Selma, Ala.; Sheehan Pipe Line Construction Co., contractor. Jim Brown, Meridian, Miss., spreadman.

Southern Natural Gas Co.—24 miles, 24-in., under way, loops to Mississippi, Alabama, Georgia; Sheehan Pipe Line Construction Co., contractor. Jim Brown, R. H. Brown, spreadmen.

Southern Natural Gas Co.—95 miles, 18-in., under way, Gwinville to Mississippi-Alabama state line; completion due November 1; Sheehan Pipe Line Construction Co., contractor. J. W. Brown, spreadman.

Southern Natural Gas Co.—85 miles, 18-in., under way, Mississippi-Alabama state line to Selma, Ala.; completion due November 1; Sheehan Pipe Line Co., contractor. C. M. Brown, spreadman.

Southern Natural Gas Co.—110 miles, 11-in., considered, extension.

Southern Natural Gas Co.—118 miles, 13-in., planned, extension.

Southern Natural Gas Co.—138 miles, 20-22-in., planned, Chattanooga, Tenn., to Lexington, Miss.

Southern Natural Gas Co.—171 miles, 16-planned, extension.

Southern Natural Gas Co.—225 miles, 16-in., planned, Colfax, Ga., extension.

Southern Natural Gas Co.—314 miles, 18-in., planned, extension.

Southern Natural Gas Co.—375 miles, 24-in., planned, Gwinville, Miss., to Atlanta, Ga.

Southern Union Gas Co.—78 miles, 8-10-14-in., planned, New Mexico loops and laterals.

Tennessee Gas Transmission Co.—105 miles, 16-in., under way, Bayou Sale to Kinder, La.; Latex Construction Co., contractor. H. L. Peake, superintendent.

Tennessee Gas Transmission Co.—63 miles, 26-in., under way, south bank of Mahoning River, near Youngstown, Ohio, and extending southwestward. H. C. Price, contractor. G. A. Reutzel, Columbiana, Ohio, superintendent.

Tennessee Gas Transmission Co.—63 miles, 26-in., under way, north bank of Muskingum River, and extending northeastward. H. C. Price Co., contractor. R. K. Shivel, Zanesville, Ohio, superintendent.

Tennessee Gas Transmission Co.—47 miles, 26-in., under way, south bank of Muskingum River, and extending southwestward, early fall; H. C. Price Co., contractor. W. B. Williams, McConnelsville, Ohio, superintendent.

Tennessee Gas Transmission Co.—47 miles, 26-in., under way, north bank of Ohio River, and extending northeastward. H. C. Price Co., contractor. C. R. Ice, Portsmouth, Ohio, superintendent.

Tennessee Gas Transmission Co.—700 miles, 20-26-in., planned, Burnaugh, Ky., to Massachusetts including 400-mile line to Buffalo.

Tennessee Gas Transmission Co.—95 miles, 20-in., under way, Natchitoches to Kinder, La.; Latex Construction Co., contractor. F. A. Silar, superintendent.

Tennessee Gas Transmission Co.—992 miles, 30-in., planned, first 150 miles of loops to be laid at Monroe, La., Greenville, Miss., Midland and Portland, Tenn.

Tennessee Gas Transmission Co.—70 miles, 26-30 in., contracted, between Stations 104 and 110; Anderson Brothers Corp., contrac-

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tor. E. C. McCoy and Arkie Hobson, Richmond, Ky., spreadmen.

Tennessee Gas Transmission Co.—174 miles, 30-in., under way, western Tennessee and Kentucky; Price-Morrison, contractor. Jack Hodges and R. L. McMillon, superintendents.

Tennessee Gas Transmission Co.—74 miles, 30-in., under way, from near Glasgow northeastward to near Lebanon, Ky; Morrison Construction Co., contractor. R. L. McMillon, Scottsville, Ky., spreadman.

Tennessee Gas Transmission Co.—28 miles, 30-in., under way, near Scottsville, southwestward to near White House, Tenn.; Morrison Construction Co., contractor. R. L. McMillon, Scottsville, Ky., spreadman.

Tennessee Gas Transmission Co.—99 miles, 30-in., under way, near Dickson, southwestward to near Selmer, Tenn.; H. C. Price, contractor. Jack Hodges, Dickson, Tenn., spreadman.

Tennessee Gas Transmission Co.—170 miles, 26-30-in., contracted, Kentucky; Anderson Brothers Corp., contractor.

Texas Eastern Transmission Corp.—1,400 miles, 26-in., planned, Texas to Pittsburgh, loops.

Texas Gas Transmission Corp.—33 miles, 12-in., authorized, Slaughters, Ky., to Evansville, Ind.

Texas Gas Transmission Corp.—723 miles, 26-in., under way, Lisbon, La., to Middletown, Ohio.

Texas-Illinois Natural Gas Pipeline Co.—53 miles, 20-in., lateral from Joliet terminal to connection with Natural Gas Pipeline Co. of America near Volo, Ill.

Texas-Illinois Natural Gas Pipeline Co.—1,300 miles, 30-in., approved, Corpus Christi area to Joliet, Ill.

Texas-Illinois Natural Gas Pipeline Co.—100 miles, 26-in., under way, La Gloria to Refugio, Tex.; Midwestern Constructors, Inc., contractor of Schedule 1.

Texas-Illinois Natural Gas Pipeline Co.—100 miles, 30-in., under way, Mississippi River to Effingham, Ill.; Midwestern Constructors, Inc., contractor of Schedule 11.

Texas-Illinois Natural Gas Pipeline Co.—117 miles, 30-in., to start in 1951, Effingham to Sibley, Ill.; Midwestern Constructors, Inc., contractor to Schedule 12.

Texas-Illinois Natural Gas Pipeline Co.—92 miles, 30-in., to start in 1951; Sibley to Joliet, Ill.; Midwestern Constructors, Inc., contractor of Schedule 13.

Texas-Illinois Gas Pipe Line Corp.—420 miles, 30-in., contracted, Arkansas and Missouri; Bechtel Corp.

Texas-Illinois Gas Pipe Line Corp.—126 miles, 30-in., contracted; H. C. Price, contractor.

Texas-Illinois Gas Pipe Line Corp.—113 miles, 30-in., contracted; H. C. Price, contractor.

Texas-Illinois Gas Pipe Line Corp.—97 miles, 26-in., contracted; H. C. Price, contractor.

Texas-Illinois Gas Pipe Line Corp.—36 miles, 24-in., contracted; H. C. Price, contractor.

Texas-Illinois Gas Pipe Line Corp.—38 miles, 12-in., contracted; H. C. Price, contractor.

Transcontinental Gas Pipe Line Corp.—1,840 miles, 30-in., under way, Rio Grande Valley, Texas, to New York City.

Transcontinental Gas Pipe Line Corp.—80 miles, 10-14-in., underway, Mercedes to south of Falfurrias, Tex.; Massey Construction Co., contractor of Schedule A.

Transcontinental Gas Pipe Line Corp.—108 miles, 24-in., under way, south af Falfurrias to Edna, Tex.; H. B. Zachry Co., contractor of Schedule B.

Transcontinental Gas Pipe Line Corp.—92 miles, 30-in., under way, Porters to Deweyville, Tex.; Texas Southern Contracting Co., contractor of Schedule D. Merle Tatum, Liberty, Tex., spreadman.

Transcontinental Gas Pipe Line Corp.—81 miles, 30-in., under way, Sabine River, to Eunice, La.; Anderson Bros. Corp., contractor of Schedule E.

Transcontinental Gas Pipe Line Corp.—100 miles, 30-in., under way, Catawba River, North Carolina, to North Carolina-Virginia boundary; R. H. Fulton & Co., contractor of Section 9. A. A. Corrigan and Clark Williams, superintendents.

Transcontinental Gas Pipe Line Corp.—86 miles, 30-in., under way, North Carolina-Virginia boundary to James River, Virginia; O. R. Smith Contracting Corp., contractor of Section 10. R. M. Jones, Altavista, Va., spreadman.

Transcontinental Gas Pipe Line Corp.—110 miles, 30-in., under way, James River, Virginia, to Potomac River, Virginia; O. R. Smith Contracting Corp., contractor of Section 11. C. C. Craig, Herndon, Va., spreadman.

Transcontinental Gas Pipe Line Corp.—75 miles, 30-in., contracted, Potomac River to Susquehanna River; Associated Pipe Line Contracting, Inc., contractor of Section 12. Cecil Rogers, Towson, Md., spreadman.

Transcontinental Gas Pipe Line Corp.—90 miles, 30-in., contracted, Susquehanna, Pa., to Delaware River; Wunderlich & Griffis Construction Co., contractor of Section 13.

Transcontinental Gas Pipe Line Corp.—61 miles, 30-in., contracted, Delaware River to Hackensack River, New Jersey; Wunderlich & Griffis Construction Co., contractor of Section 14.

Transcontinental Gas Pipe Line Corp.—32 miles, 30-in., under way, Edgewater to Elizabeth, N. J.; Oklahoma Contracting Co., contractor to Schedule 15. Louis Visentine, Edgewater, N. J., superintendent.

Transcontinental Gas Pipe Line Corp.—68 miles, 6-14-in., under way, Wharton, Tex., area; Altgelt Construction Co., contractor, Texas Unit 1.

Transcontinental Gas Pipe Line Corp.—38 miles, 4-14-in., under way, El Campo, Tex., area; T & R Construction Co., contractor, Texas Unit 1.

Transcontinental Gas Pipe Line Corp.—38 miles, 4-8-in., under way, Sinton, Tex., area; Shanks & Eustace, Inc., contractor, Texas Unit 2.

Transcontinental Gas Pipe Line Corp.—61 miles, 6-10-in., under way, Dix, Tex., area; Victoria Oil Field Maintenance Co., contractor, Texas Unit 2.

Transcontinental Gas Pipe Line Corp.—50 miles, 18-20-in., under way, Eunice, La., to the south; Texas Southern Contracting Co.,

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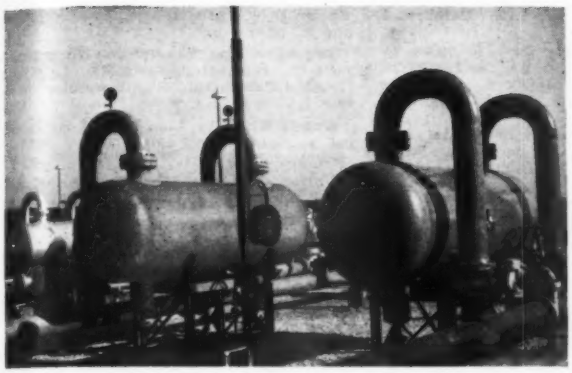

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Fig. 3169 single stage, open impeller centrifugal

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APPLICATIONS

Goulds designed the Fig. 3169 especially for general water service, irrigation, Slurries, circulation, transfer and factory wastes. It also gives excellent service in air conditioning, plumbing, heating, processing and related applications.

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The most important advantage of these pumps is their efficient, modern design. Simple construction, light weight and compact size give you reasonable prices and unusually good service over a long period of time.

CAPACITIES

Fig. 3169 is made in 10 sizes for both motor and belt drives. Capacities to 1000 G.P.M. with heads to 180 ft., depending on capacity.

For more information call or write Pump Headquarters or your nearest Goulds dealer. Ask for Bulletin 720.4.

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Seneca Falls New York

XUM

contractor, Texas Unit 2. Jim Reed, Crowley, La., spreadman.

Transcontinental Gas Pipe Line Corp.—380 miles, 8-16-in., planned, laterals to gas field.

Transcontinental Gas Pipe Line Corp.—85 miles, 4-14-in., under way, South Louisiana; Latex Construction Co., contractor. J. B. Latham, Vinton, La., spreadman.

Transcontinental Gas Pipe Line Corp.—78 miles, 30-in., contracted, Delaware River to southwest; Ray L. Smith & Son, Inc., contractor. Joe L. Work, Newton, Pa., spreadman.

Trunkline Gas Co.—278 miles, 20-in., contracted, Valley of Texas; R. H. Fulton & Co., contractor.

Trunkline Gas Co.—18 miles, 26-in., contracted, Mississippi, Tennessee, and Kentucky; R. H. Fulton & Co., contractor.

Trunkline Gas Supply Co.—1,775 miles, 10-26-in., planned, includes 740-mile, 26-in., Lake Charles, La., to Tuscola Station of Panhandle Eastern Pipe Line Co., and 1,035 miles, 10-24-in., Lake Charles, La., to McAllen, Tex., completion due October 1, 1952.

Trunkline Gas Supply Co.—176 miles, 26-in., under way, Darnell, La., to Longville, La.; Houston Contracting Corp., contractor of Section A, main line. E. C. Norris, Rayville, La., spreadman.

Trunkline Gas Co.—180 miles. 26-in., contracted, Darnell, La., to Senatobia, Miss.; Anderson Bros. Corp., contractor, Section B, main line.

Trunkline Gas Supply Co.—184 miles, 26-in., under way, Senatobia, Miss., to Paducah, Ky.; R. H. Fulton & Co., contractor of Section C, main line. Ed Veach, Memphis, Tenn., spreadman.

Trunkline Gas Co.—186 miles, 26-in., contracted, Joppa to Tuscola, Ill.; Mahoney Contracting Co., contractor of Section D, main line.

Trunkline Gas Co.—262 miles, 20-in., contracted, McAllen to Altair, Tex.; R. H. Fulton & Co., contractor of Section E and F, lateral lines.

Trunkline Gas Co.—217 miles, 24-in., contracted, Longville, La., to Altair, Tex.; Anderson Bros. Corp., contractor of Sections G and H, lateral line.

Trunkline Gas Supply Co.—71 miles, 20-16-10-in., contracted, Longville, La., south; Houston Contracting Co., contractor of Section 1, lateral line.

United Gas Pipe Line Co.—51 miles, 12¾-in., proposed, Soso and Sherron fields, to near Meridian, Miss.

United Gas Pipe Line Co.—23 miles, 16-in., proposed, Mud Lake field, La., to near Port Arthur, Tex.

United Gas Pipe Line Co.—93 miles, 6 to 16-in., proposed, fields in Plaquemines Parish to near New Orleans.

United Gas Pipe Line Co.—26 miles, 20-in., planned, Louisiana, connecting with East Texas system.

United Gas Pipe Line Co.—90 miles, 16-in., planned, West Bay field to New Orleans.

Utah Natural Gas Co.—325 miles, 22-in., proposed, "Four Corners" in southeastern Utah.

Valley Gas Pipe Line Co., Inc.—500 miles, 24-in., proposed, Berclair, Goliad County, to northeast Saratoga, Hardin County, Texas, to Vermilion Bay area of Louisiana.

Valley Gas Pipe Line Co., Inc.—1,000 miles, 30-in., proposed, Saratoga northeast to Arcadia, La., to El Dorado and Jonesboro, Ark., Cape Girardeau, Mo., Lawrenceville, Ill., Terre Haute, Ind., and Atlanta, Ind., thence to northeast terminal point in southern Michigan.

Virginia Natural Gas Co.—153 miles, Buckingham to Richmond and Portsmouth, Va.

Foreign Crude-Oil Pipe Lines

Basrah Petroleum Co.—72 miles, 12¾ and 16-in., under way, Zubair to Fao, Iraq; headquarters, Basrah, Iraq.

Cia. de Petroleo Ganso Azul, Ltda.—48 miles, 4-in., planned, Ganso Azul field to Pucallpa on upper Ucayali River, Peru.

Condor S.P.A. (Shell).—80 miles, planned, Genoa to Rho, near Milan, Italy.

Direccion General de Yacimientos Petroliferos Fiscales.—409 miles, under way, Plaza Huincul to Bahia Blanca, Argentina.

Estrada de Ferro Santos a Jundiai.—32 miles, 10-18-in., under way, Santos to Sao Paulo, Brazil; Arthur Levy, Brigaderro, Sao Paulo, superintendent.

Interprovincial Pipe Line Co.—1,150 miles, 16-18-20-in., under way, Edmonton, Alta., to Superior, Wis.

Interprovincial Pipe Line Co.—450 miles, 20-in., under way, Edmonton to Regina; Canadian-Bechtel, Ltd., associated with Fred Mannix Co.; H. Lem Stevens, Guille, Edmonton, Alta., spreadman.

Interprovincial Pipe Line Co.—340 miles, 16-in., under way, Regina to Gretna, Man.; Williams Brothers Corp., contractor; R. E. Trammell, Regina, spreadman.

Interprovincial Pipe Line Co.—360 miles, 18-in., under way, Gretna to Superior, Wis.; Anderson Brothers Corp., contractor; W. F. Davis, Superior, spreadman.

Iraq Petroleum Co., Ltd.—556 miles, 30-in., under way, Kirkuk to Banias; Bechtel-Kirkuk, contractor. Tripoli, Lebanon.

Middle East Pipelines, Ltd.—800 miles, 34-36-in., planned, Iran to a Levantine port.

Montreal Pipe Line Co., Ltd.—68 miles, 18-in., under way, near Highwater, Que.; to Montreal East; Fred Mannix & Co., contractor of Section 3. B. V. Elliott, Cowansville, Que., superintendent.

Petroleos Mexicanos.—160 miles, 11-in., authorized, Minatitlan to Salina Cruz, Mexico.

Petroleos Mexicanos.—145 miles, 13-in., considered, Reynosa to Monterrey, Mexico.

Trans-Arabian Pipe Line Co.—1,068 miles, 30-31-in., under way, Abqaiq, Saudi Arabia, to Sidon, Lebanon.

Trans-Arabian Pipe Line Co.—850 miles, 30-31-in., under way, Abqaiq, Saudi Arabia, to Sidon, Lebanon; International Bechtel, Inc.

Trans-Arabian Pipe Line Co.—218 miles, 30-31-in., under way, Abqaiq, Saudi Arabia, to Sidon, Lebanon.

Winnipeg Pipe Line Co., Ltd.—75 miles, 10-in., under way, Gretna to Winnipeg, Manitoba; Sparling-Fowler Co., Ltd.

Foreign Natural-Gas Pipe Lines

Azienda Generale Italiana Petroli, under way, Lodi to Milan, Italy.

Azienda Generale Italiana Petroli, under way, Lodi to Turin, Italy.

Azienda Generale Italiana Petroli, under way, Lodi to Genoa, Italy.

Direccion General del Gas del Estado.—310 miles, 8-in., under way, Plaza Huincul to Neuquen, Argentina, to the vicinity of General Conesa, Argentina.

Direccion General del Gas del Estado.—2 miles, under way, Comodoro Rivadavia to Caleta Olivia, Argentina.

Northwest Natural Gas Co.—950 miles, 24-in., planned, Alberta fields to Vancouver, B. C., Seattle, Wash., and Portland, Ore.

Petroleos Mexicanos.—205 miles, 16-in., considered, Monterrey to Torreon, Mexico.

Petroleos Mexicanos.—260 miles, 20-in., considered, Monterrey to Tampico and Poza Rica, Mexico.

Petroleos Mexicanos, Mexican Gas Co., and Industrial Gas Co.—600 miles, planned, Reynosa, Tamaulipas, to Mexico City, D. F.

Westcoast Transmission Co., Ltd.—1,406 miles, 30-in., planned, northern Alberta to Vancouver, B. C., and northern California.

Western Pipe Lines.—710 miles, 22-24-in., planned, Alberta fields via Saskatoon, Sask., to Winnipeg, Man., Canada.

Foreign Products Pipe Lines

Cia. des Pipe Lines Petroliers Francias.—150 miles, 10-in., planned, Le Havre to Paris, France.

Colombian Ministry of Petroleum.—90 miles, 6-in., planned, Puerto Berrio to La Dorada, Colombia.

Colombian Ministry of Petroleum.—103 miles, 4-in., planned, Puerto Berrio to Medellin, Colombia.

Colombian Ministry of Petroleum.—75 miles, 4-in., planned, Buena Ventura to Cali, Colombia.

Creole Petroleum Corp.—10 miles, 8-in., under way, Catia de la Mar to Nueva Caracas, Venezuela.

Northern Pipe Line, Ltd.—300 miles, 10-in., under way, Montreal, Que., to Toronto, Ont., Canada.

Petroleos Mexicanos.—160 miles, 11-in., under way, Minatitlan to Salina Cruz, Mexico.

State of Cundinamarca, Colombia.—120 miles, Puerto Salgar, to Bogota.

Svenska Enterprenad Atkiebolget.—220 miles, planned, Uddevalla to Vasteras, Sweden.

El Paso Opens Offices

FARMINGTON, N. M.—El Paso Natural Gas Co. has opened construction headquarters in Gallup, N. M., and Flagstaff, Ariz., and will begin work on its new $4,500,000 natural-gas pipe line from the San Juan basin to the California-Arizona border next week. First work will get under way near Farmington.

The Gallup headquarters will handle construction from the San Juan basin to Gallup, and to Ganado, Ariz., and the Colorado River. The Flagstaff office, to be operating within the next couple of weeks, will handle construction on the western portion of the line.

Clearing of the 50-ft. right-of-way and laying of the line is expected to progress at the rate of 2 miles per day. The entire project will be completed by January 1, 1951.

A new financial structure, ordered by the Federal Power Commission when El Paso was given approval to construct the line, is now being drafted by the company.

The line will tie in to Pacific Gas & Electric Co.'s line near Topock, Ariz. P.G.&E.'s big-inch line goes on to the San Francisco Bay area.

Storage Pipe Line

WASHINGTON.—Authority to build a 19½-mile pipe line to deliver natural gas into its storage area is asked by Hope Natural Gas Co., Clarksburg, W. Va. Application to the Federal Power Commission recites that the proposed facilities would increase the company's pipe-line capacity by 1,000,000 cu. ft. daily.

Location of the 18-in. transmission line would extend southeasterly from Hope's Tonkin compressor station in Doddridge County, West Virginia, to its Lewis County storage area. It would permit Hope to increase its ultimate volume of gas in the storage area by approximately 25 billion cubic feet.

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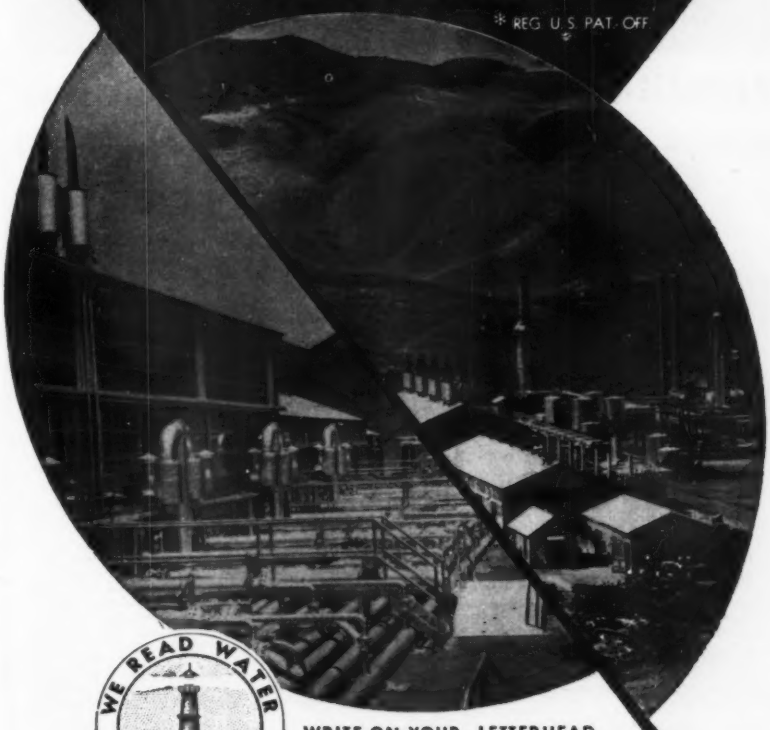

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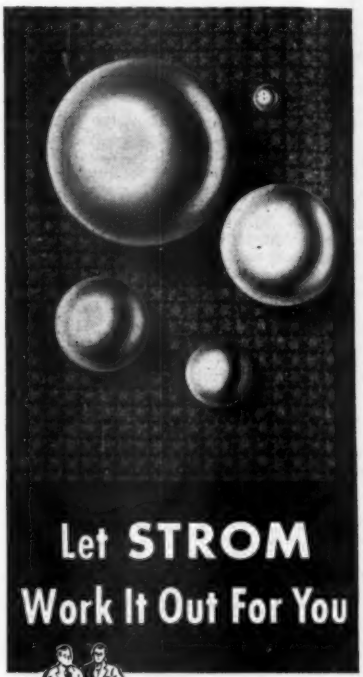

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QUESTIONS on TECHNOLOGY

by W. L. Nelson
Consulting Engineer

Penetration of Asphalt Blends

How do you estimate the penetration of a mixture of asphalts? We have encountered strange results which are enclosed.—R. C. M.

Little appears in the literature on the subject of asphalt blends. Perhaps this is due to confusion that arises when two dissimilar asphalts are blended. Dissimilar asphalts produce blends that bear no clear relation to the penetrations of the two stocks that are blended. Thus in Table 1 the penetrations of the blends are usually higher than the penetrations of the two components (Abraham—Asphalts and Allied Substances, fourth edition, page 481, D. Van Nostrand Co., New York, 1937). In Table 1, a 37-penetration blown asphalt is being mixed with each of two 30-penetration steam-refined asphalts. This strange behavior appears to occur mainly when blending two dissimilar asphalts that are of about the same penetration.

An entirely different behavior is indicated in Tables 2, 3, 4, and 5 which are blends of similar or somewhat similar asphalts. Note also that the penetrations of the two components are generally quite different from one another. All of these data (Tables 2-5) can be represented with fair accuracy by the empirical correlation shown in Fig. 1. The penetration of the blends is somewhat dependent on the difference between the penetrations of the two blending stocks. This is indicated in Fig. 1 by a series of lines ranging from 25 up to 200. The 25 line means that the penetration of one of the stocks is 25 units higher than the penetration of the other—as illustrations, 25-50, 75-100, 100-125, etc. The "Percentage of Penetration Range" scale shows the penetration of the blend as a fraction (or percentage) of the difference in penetration of the two blending agents. Thus, the penetration of a blend is equal to the penetration of the low-penetration stock plus a fraction of the penetration range.

As an example, the penetrations for the last blend (No. 11) of Table 2 will be computed. A line representing a difference in penetration of 60 should be used. For a 25 per cent blend, Fig. 1 indicates that about 17 per cent of the penetration range has been traversed. Thus, 0.17 × 60 + 40 is the penetration of the blend, of 50.2.

25% blend 0.17 × 60 + 40 = 50.2
50% blend 0.38 × 60 + 40 = 62.8
75% blend 0.645 × 60 + 40 = 79.7

Other computed values are shown in Tables 4 and 5.

The accuracy of Fig. 1 is not good but at least it indicates some of the relationships that are involved.

TABLE 1

Blending Blown and Steam Refined Asphalts of About the Same Penetration

Percentages in blend		Penetration at 77° F.	
Blown	Steam refined	Asphalt No. 1	Asphalt No. 2
0	100	30	30
10	90	34	35
20	80	49	44
30	70	65	54
40	60	73	56
45	56	77	..
50	50	67	57
60	40	60	..
70	30	..	50
100	0	37	37

TABLE 5

Blend of Two Petroleum Asphalts (16 and 108 Penetration)

Percentage of high penetration asphalt	Penetration of blend	
	Experimental	From Fig. 1
0	16	16
6	17	19.7
10	19	21.5
12	21	23
15	23	24.5
100	108	108

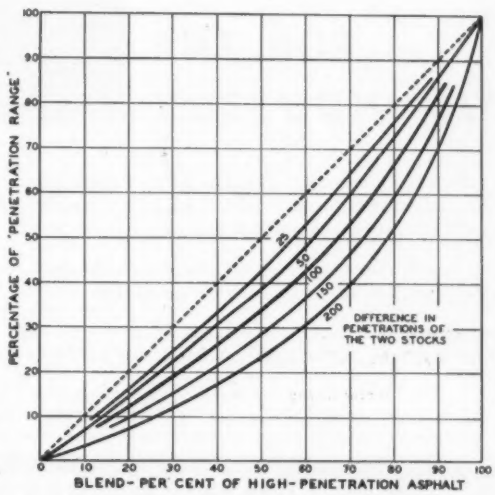

Fig. 1—Chart for estimating the approximate penetration of blends of similar asphalts.

TABLE 2—BLENDS OF VACUUM ASPHALTS—EACH BLEND CONSISTING OF TWO ASPHALTS FROM THE SAME CRUDE OIL

Percentage, high-penetration asphalt	Penetrations of asphalts and blends, at 77° F.										
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
0	25	25	25	50	50	100	25	25	75	25	40
10	32	29	..	..	55	..	..	..	..	29	..
25	42	36	53	65	63	123	33	33	82	35	50
50	68	56	92	83	84	148	42	48	93	49	63
75	111	98	135	111	109	170	55	58	108	74	80
90	158	144	..	..	132	..	..	..	..	94	..
100	200	200	200	150	150	200	75	75	125	120	100

TABLE 3—BLENDS OF TRINIDAD AND PETROLEUM ASPHALTS

0-120 penetration		0-94 penetration		0-250 penetration	
Percentage of petroleum asphalt	Penetration of blend	Percentage of petroleum asphalt	Penetration of blend	Percentage of petroleum asphalt	Penetration of blend
0	0	0	0	0	0
50	40	55	40	30	20
60	50	65	50	40	30
65	59	75	60	43.5	40
69	70	84	70	47.5	50
76	80	90	80	52	60
100	120	100	94	55.5	70
..	..	..	..	60	80
..	..	..	..	100	250

TABLE 4—BLENDS OF BERMUDEZ AND PETROLEUM ASPHALTS

20-130 penetration			20-96 penetration		
Percentage of petroleum asphalt	Penetration of blend		Percentage of petroleum asphalt	Penetration of blend	
	Experimental	From Fig. 1		Experimental	From Fig. 1
0	20	20	0	20	20
25	40	36.5	30	40	35.5
30	44	40	39	45	41
35	49	55	46	50	45.5
100	130	130	100	96	96

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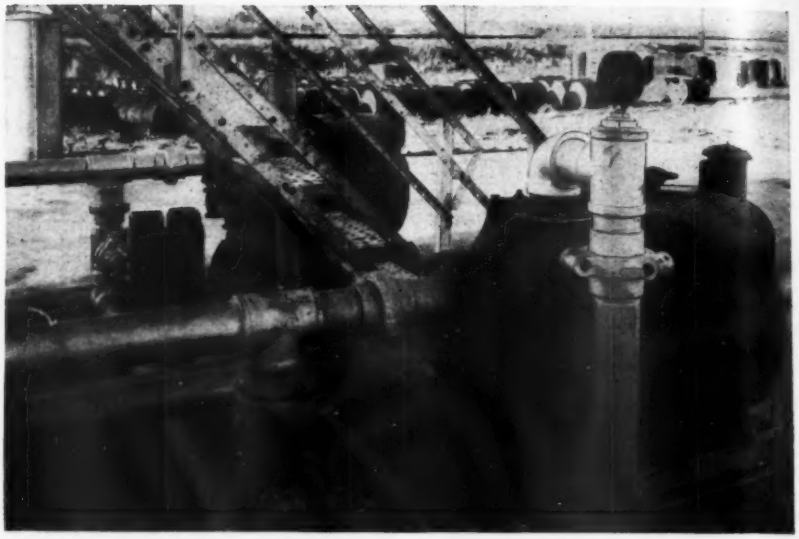

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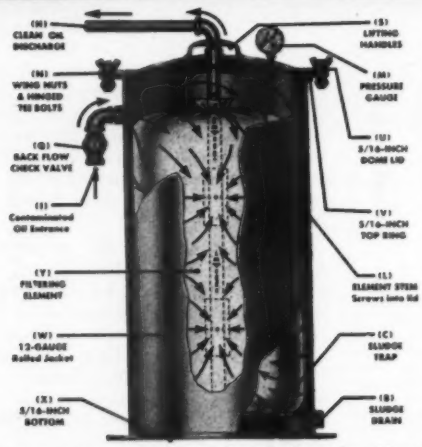
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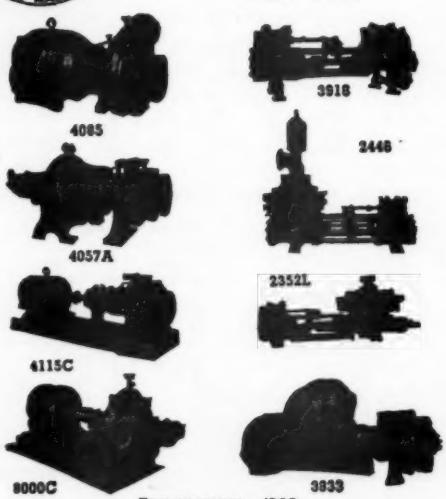

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Effect of Gravity Drainage

THE presence of a gravity-drainage control may be indicated by production behaviors which result from that mechanism. Some of these will be discussed here, ideal or extreme situations being considered to illustrate the concept. Some criteria can be applied earlier in the life of a reservoir than can others, and it is perhaps unfortunate that at times the evidence is not available until a depletion stage has been reached.

Perhaps the most obvious evidence pointing to gravity drainage is a measurement of the drainage itself. This can be done only after a reservoir has been producing for some time and it requires the knowledge of supplementary material to use in making comparisons. However, if drainage is occurring, those wells lowest on structure should recover the highest cumulative oil production by virtue of their position. The amount of additional oil recovered by gravity drainage would be dependent upon individual conditions.

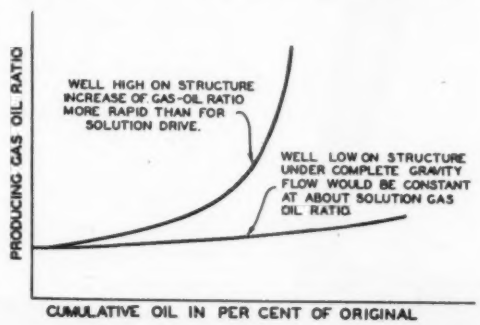
Consider two wells on a structure, one high and one low. At the time these wells are drilled either might produce primarily by a solution gas drive, depending upon the amount of pressure drawdown imposed at either location. Even though they do so produce, there will be some drainage to the lower part of the reservoir from those regions not under the influence of the pressure sink of the high well or wells. After the pressure is depleted somewhat, this drainage will occur over greater portions of the reservoir.

An evaluation of the additional cumulative oil produced by the low well might be made by a comparison of performance curves showing pressure versus cumulative oil or gas oil ratio versus cumulative oil. The lower well will not only produce more oil ultimately, but because of oil drainage into that portion of the reservoir during production, the average oil saturation will remain higher and consequently the producing gas-oil ratio will remain lower. The production histories of the two wells is compared in Fig. 1. This assumes that the reservoir is homogeneous. Any variation in homogeneity between the areas drained by the two wells would have to be taken into account before the comparison could be made. It is assumed also that the cumulative productions are not compared barrel for barrel but in terms of the percentage production of oil available.

Another evaluation of additional oil produced at the low well due to drainage can be made by comparing actual production with the estimated oil in place as determined by core and logging data. There are some known instances of gravity drainage where low structural wells produced more oil than could have been present within a reasonable gravity-free drainage area. Unfortunately, this comparison cannot be made until late in the life of a reservoir, although earlier estimates can be made of the expected recovery by using decline curves.

A third evaluation of additional oil produced at the lower well can be made by a comparison of expected ultimate recoveries of the two wells based upon decline curves, if such are available. This comparison must be made on the basis of the oil in place at the two locations, and is in effect a comparison of the recovery factors expected. At the higher location something less than a solution-gas-drive recovery factor would be expected, and at the lower location something in excess of a solution-gas-drive recovery would be expected.

The effect of drainage might also be seen in production decline curves for wells high and low on structure. This has been suggested by Lewis[1] who gives examples of a decline change. The nature of his example is illustrated here as Fig. 2, which shows the more rapid decline of producing capacity by the well higher on structure and shows an apparent loss of available oil for production in the high region of the reservoir by the sharp break in the decline. This break occurs when the drainage can overcome the producing gradient into the high structure well. The comparison of high and low wells on Fig. 2 must be made with recognition of other possible contributing factors, such as differences in permeability, etc. Such differences could account for the differences in rate of decline, but could not so readily account for the sharp break in decline.


PRODUCING GAS OIL RATIO
WELL HIGH ON STRUCTURE INCREASE OF GAS-OIL RATIO MORE RAPID THAN FOR SOLUTION DRIVE.
WELL LOW ON STRUCTURE UNDER COMPLETE GRAVITY FLOW WOULD BE CONSTANT AT ABOUT SOLUTION GAS OIL RATIO
CUMULATIVE OIL IN PER CENT OF ORIGINAL

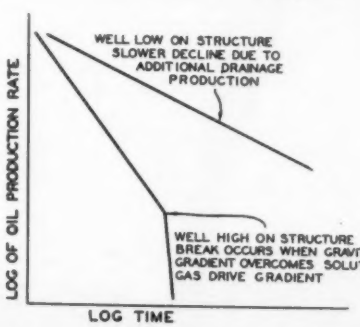

LOG OF OIL PRODUCTION RATE
WELL LOW ON STRUCTURE SLOWER DECLINE DUE TO ADDITIONAL DRAINAGE PRODUCTION
WELL HIGH ON STRUCTURE BREAK OCCURS WHEN GRAVITY GRADIENT OVERCOMES SOLUTION GAS DRIVE GRADIENT
LOG TIME

Fig. 1—(Left) Variation of well performance where gravity drainage is considered. Fig. 2—(Right) Variation of production decline where gravity drainage is considered.

Reference

1. J. O. Lewis. Gravity Drainage in Oil Fields. A.I.M.E. Trans. 144, Vol. 155.

Series by Dr. John C. Calhoun, Jr., Chairman, Petroleum Engineering School, Penn State College

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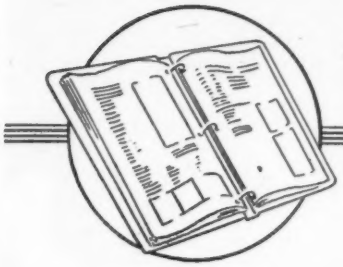

THE REFINER'S notebook

Ratio and Metered Control Adjustments

APPLICATION of pneumatic transmission adds considerable flexibility to refinery control systems. Some of the features of pneumatic transmission, reviewed in the Refiner's Notebook *(July 13, 1950, page 105)*, included possibility of locating controllers or recorders on a panel board remote from point of measurement. Another feature, of particular importance on large installations, is interchangeability of receiver controllers. The pneumatic-transmission principle is also employed in ratio and metered control systems *(Refiner's Notebook, July 20, page 109 and July 27, page 341)*.

Ratio and Metered Control

In these specialized control systems two or more variables, directly or indirectly related, are measured or controlled in an interlocked system. A ratio controller acts to adjust the control point of another instrument regulating a secondary variable according to changes in magnitude of the primary variable. A fixed ratio exists between the values or magnitudes of the two variables. The primary instrument, in ratio control, is ordinarily a transmitter.

In metered control the primary or master instrument continuously adjusts the control point of a second instrument (sometimes called a pneumatic set controller) by means of a positioning (receiving) unit connected to and automatically changing the control index of the second instrument. Output air pressure of the master controller actuates the positioning unit in the second controller and output pressure of the latter actuates the control valve. No fixed ratio exists between magnitudes of master and secondary variables in metered control. The master instrument may be a transmitter or a controller employing proportional, proportional-reset, or three-function control mode.

Ratio Adjustment

As previously noted, ratio control consists of a transmitter-receiver system in which the primary variable is measured and the secondary variable is measured and controlled to maintain a fixed relationship between the two. Output air pressure from the primary transmitter goes to the ratio controller which incorporates also an adjusting mechanism through which the control index for the secondary variable is shifted. Balance is obtained by means of a receiving bellows in the adjusting system and a controller output bellows with a parallelogram linkage between the two. Since the control index is being continuously shifted according to changes in primary flow, proportional-reset mode is ordinarily employed in the control system of the ratio controller.

In addition to proportional band and reset adjustment the ratio controller may be provided with a ratio adjustment, with a dial or scale and pointer showing the ratio setting, so that the basic ratio can be altered without changing meter range tubes. Either evenly graduated or square-root charts may be used, but the primary and secondary meters must be of the same type. Considine and Ross[2] have presented plots of the ratio adjustment relationship, when using linear charts, for one make of ratio controller. Movement of the primary pen versus that of the secondary index is plotted, at different ratio settings, in percentage of full scale movement. A 100 per cent setting on this particular instrument means that the original or basic ratio, as established by process factors, will be maintained. The basic ratio can be halved by a ratio setting of 50 per cent or doubled by a setting of 200 per cent. For square-root charts a similar plot is made relating primary to secondary flow. Comparison of linear and square-root charts in terms of range of ratio adjustment is also made by Werey[3].

Plots relating movement of primary (adjusting) pen to that of secondary (control) pen at various adjusting ratios for another make of instrument have also been presented[4]. Note should also be taken of the zero adjustment in the ratio controller and of the fact that control action may be in reverse (air pressure decreases as chart reading increases) or direct (air pressure increases with increase in chart reading).

Adjustments in Metered Control

In cascade control, where the secondary or pneumatic set controller is provided with a pneumatic adjustment or remote index setting device the relation between controlled air pressure and position of the secondary control index may be fixed or may be provided with an adjustable index setting mechanism by which the operator can manually adjust the percentage of the instrument scale over which the pneumatic set controller operates. Adjustment can be made with regards to air pressure at which initial movement of the secondary control index begins, as well as amount of index movement, or its rate of movement, for a given change of air pressure. These are termed zero and span adjustments in a detailed discussion by Burdick[5].

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1. Eckman, D. P., Principles of Industrial Process Control, John Wiley & Sons, New York.

2. Considine, D. M., and Ross, S. D., "Ratio Flow and Metered Control . . ." Chem. Eng. Progress, Sept. 1947, p. 497.

3. Werey, R. B., Instrumentation . . . in the Oil Refining Industry, Brown Instrument Co.

4. Instruments and Process Control, publication of New York State Vocational Association, Delmar Publishers, Albany, N. Y., pp. 127-140.

5. Burdick, E. C., Instrumentation, May-June 1946, p. 24.

No. 38 in current series. The Refiner's Notebook has been published continuously since 1944.

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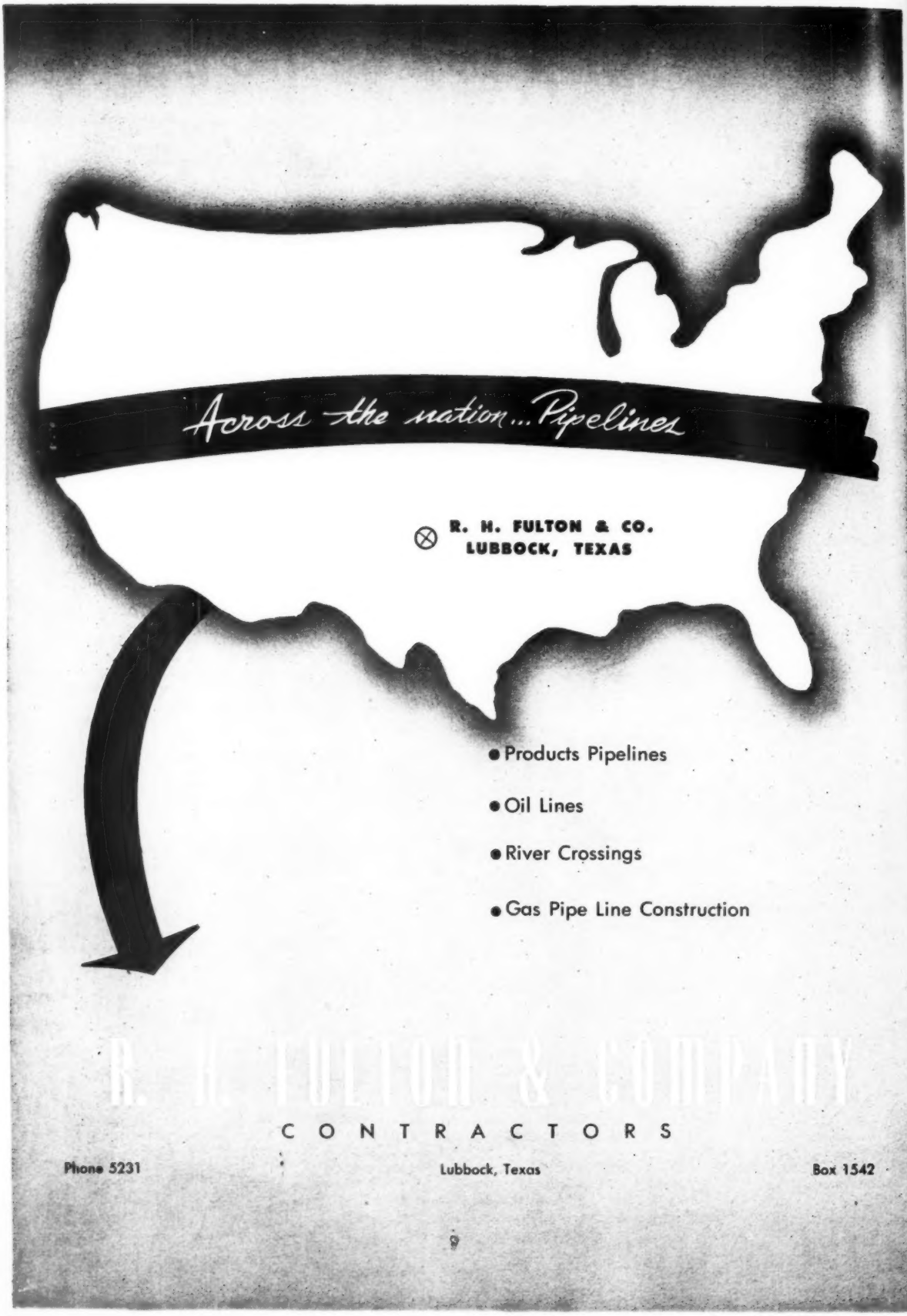
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PIPE LINES

Pasco Line Completed

SALT LAKE CITY.—Salt Lake Pipe Line Co., subsidiary of Standard Oil Co. of California, has completed its $12,000,000, 566-mile oil-products line from Salt Lake City to Pasco, Wash., the parent company announced last week.

First leg of the line, from Salt Lake to near Boise, Idaho, was completed last fall.

The 8-in. line has a capacity of 15,000 bbl. daily, with one pumping station at Salt Lake and another at Boise. Capacity could be boosted to 21,000 bbl. daily with installation of a third pumping station.

Products from Standard of California's new refinery here will be carried in the line to eight take-off points along its route, serving a large portion of the Intermountain and Northwest regions. Terminals have been installed at Ogden, Utah; Burley, Twin Falls, Boise, and Fruitland, Idaho; Baker and Adams, Ore.; and at Pasco.

Morrison-Knudsen Co., Inc.; Macco Corp.; Bechtel Corp.; Pacific Pipeline & Engineers, Ltd.; Grafe-Callahan Co.; Oklahoma Contracting Co.; and Smith Contracting Corp. were in charge of construction of the line.

The artery is utilizing a newly developed chemical marker to determine the interface between products being carried (radioactive tracers).

Parkhill Gets Contracts

TULSA.—Parkhill Truck Co., Tulsa, has been awarded contracts by Midwestern Constructors, Inc., for unloading, hauling, and stringing of pipe on a 400-mile span of Texas Illinois Natural Gas Pipeline Co.'s 1,293-mile pipe line from Texas to Illinois. Midwestern has construction contract from Texas Illinois on that portion.

Parkhill, presently committed for service on 2,286 miles of line from 8 to 30-in. in diameter, also received the following stringing contracts From W. A. Bechtel Co., San Francisco, 417 miles of Texas Illinois' lin from Texarkana, Ark., to Cap Girardeau, Mo.; and 60 miles of 20 in. for crude-oil line of Ohio Oil Co from Wood River to Patoka, Ill.

The firm is also working on 112 miles of 26-in. pipe for Mary Construction Co. on Northern Natura Gas Co.'s line from Holmes, Iowa to Farmington, Minn.; 109 miles o 26-in. for Midwestern Constructor on Northern Natural's line fron Plattsmouth, Neb., to Ogden, Iowa; 180 miles of 26-in. from Anderson Brothers Corp. on Trunkline Gas Co.'s line from Longville, La., to Garwood, Tex.; and 61 miles of smaller pipe for Houston Contracting Co. on Trunkline's system between Longville, Tex., and Southwest Louisiana

Edmonton Storage Starts

Transmission of crude oil in western Canada advanced another important step last week when flow started into the Edmonton storage tanks of Interprovincial Pipeline Co., Ltd. By late October tanks are scheduled to be filled at the pump station to ready service into the Regina refinery now nearing completion.

First Alberta crude was accepted

PIPE CASING.—This steel casing is being run through a hole which was bored under busy U. S. Highway 30 south of Chicago, and will serve as a protector for a new 16-in. crude-oil pipe line which will be laid through it. This type of "crossing" has proved to be the most feasible in congested areas where through traffic must be kept moving. The new line will transport crude from a pipeline terminal at Wilmington, Ill., to Cities Service Oil Co.'s refinery at East Chicago, Ind.

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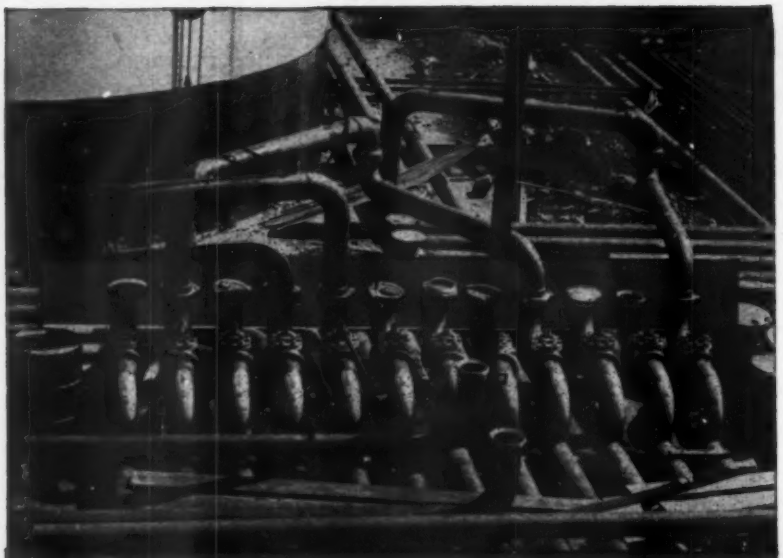

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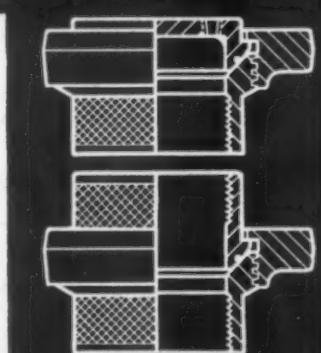

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August 25 when Interprovincial took delivery from Imperial Pipeline Co., drawing from a tank leased by Interprovincial at the Redwater field. The second crude assignment was received when Interprovincial had completed about 2 miles of 16-in. pipe to link the British American Alberta Pipeline, Ltd., field terminal with the main tank pipe line. Both shippers are now providing crude oil for the storage tanks.

A total of 933 miles of the 1,150-mile Interprovincial line has now been ditched and pipe welded. Some 911 miles of pipe has been wrapped and coated, and 878 miles of ditch has been backfilled.

In the Edmonton-Regina section, 410 miles have been ditched. Work is advancing about 20 miles weekly.

Texas Illinois May Expand

WASHINGTON. — Texas Illinois Natural Gas Pipeline Co., Chicago, which recently received Federal Power Commission approval to construct a 1,331-mile natural-gas pipe line from Texas to the Chicago area, has asked the commission to authorize additional facilities which will increase authorized capacity of the system from 305,000,000 to 374,000,000 cu. ft. daily.

The $117,000,000 line approved previously will carry natural gas from Texas to market areas in Illinois and Indiana. Contracts have already been let and work is now under way.

To accomplish the newly proposed increase in capacity of the line, Texas Illinois plans certain changes in the units powering its compressor stations and proposes to build approximately 72 miles of new line in Texas in order to deliver the additional gas to the main pipe-line system.

Estimated total capital cost of the proposed new construction program is $11,581,800.

The additional gas would be sold in part to some of Texas Illinois' presently authorized customers, with the remainder to be made available to communities along the route of the company's pipe-line system not now receiving natural gas.

Present customers which would receive additional gas are Ppblic Service Co. of Northern Illinois, Northern Indiana Public Service Co., Peoples Gas Light & Coke Co., and Western United Gas & Electric Co. In addition, Texas Illinois would make additional sales and deliveries through either the facilities of Chicago District Pipeline Co. at Joliet or into the facilities of Public Service Co. of Northern Illinois at Volo.

Texas Illinois said that it has reserved 7,705,000 cu. ft. of the proposed daily increase for the distributors of gas in the following Illinois communities: Sullivan, Altamount, Carlyle, Beckmeyer, Salem Lovington, Bement, Shattuck, Hoffman, Sandoval, and Junction City.

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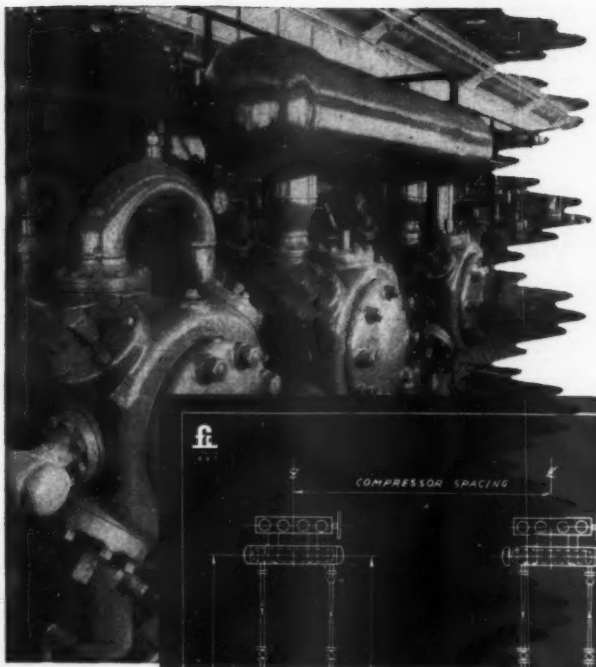

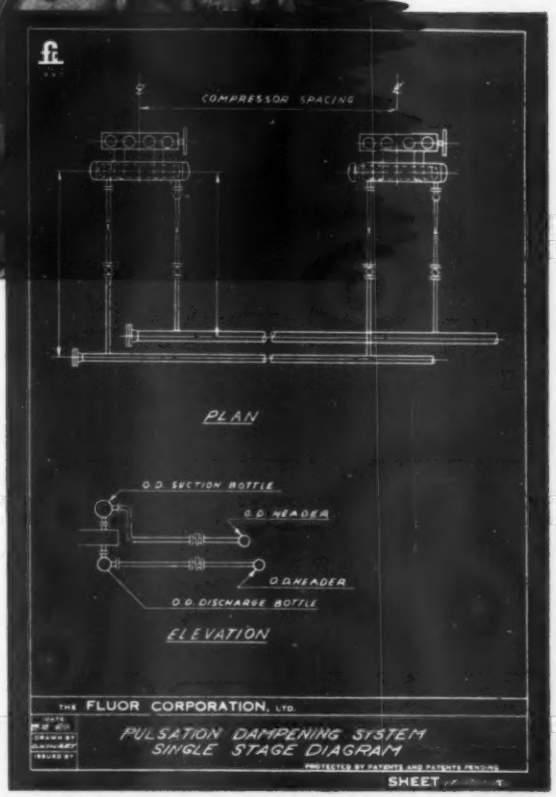

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NATURAL GAS

To Double Sales Capacity

WASHINGTON. — Added facilities to nearly double the sales capacity of the Texas-to-Michigan natural-gas pipe-line system of Michigan-Wisconsin Pipe Line Co. have been authorized in a final ruling by the Federal Power Commission.

The ruling came in answer to petitions filed by the State of Wisconsin and the Wisconsin Public Service Commission contending the merits of the previous finding. The commission rejected the protests, clearing the way for immediate development of the enlarged facilities.

Increased flow will be available to Michigan Consolidated Gas Co., of Detroit. Both Michigan-Wisconsin and Michigan Consolidated are subsidiaries of American Natural Gas Co.

One feature of the proposed improvement is the establishment of large storage facilities in the Austin and Goodwell fields of Michigan. Michigan-Wisconsin is authorized to lease from Michigan Consolidated existing storage facilities for the enlarged service.

Carthage Field Report

A Bureau of Mines petroleum-engineering study on the extensive Carthage gas field in Panola County, Texas, has been released by the United States Department of Interior.

The report was prepared by C. J. Wilhelm, principal petroleum engineer; H. M. Harris, associate petroleum engineer; and the late M. N. Harlin, former petroleum engineer of the bureau's Petroleum Experiment Station, Bartlesville, Okla.

A free copy of the publication, "Petroleum-Engineering Study of the Carthage Gas Field, Panola County, Texas," may be obtained from the Bureau of Mines, Publications Distribution Section, 4800 Forbes Street, Pittsburgh 13, Pa.

FPC Action Opposed

AUSTIN.—The Texas Independent Producers and Royalty Owners Association and more than 2,000 individual independent producers and royalty owners have petitioned the Federal Power Commission for the right to intervene in the proceedings against Phillips Petroleum Co.

They oppose FPC's contention that it has the right to fix the field price of natural gas sold by Phillips to interstate pipe lines.

R. L. Foree, Dallas, president of T.I.P.R.O., said the petitioners would make every effort to prevent FPC from issuing any order which would apply to field sales of natural gas made by independent producers and royalty owners.

Accounts System Revised

WASHINGTON.—Inventories of natural gas stored underground and the costs of exploration and development have been given a revised system of accounts by the Federal Power Commission, effective January 1, 1951.

The commission has amended its Uniform System of Accounts for Natural Gas Companies which has been mandatory since its adoption in 1939. Developments in the natural-gas industry have been so outstanding in the 10 years that the original ruling has been found to contain features that needed change.

The amendments change the system principally (1) by making provision for an accounting for inventories of natural gas stored underground, and for account classifications for storage plant and expenses; (2) by relocation and better accounting for products extraction operations, relocation from production expense of credits for gas used by the utility; and (3) by making other improvements in plant and expense classifications including the merging of exploration and development costs among production expenses.

Off-Peak Rate Hike O.K.'d

CHICAGO.—Increases in rates to interruptible and off-peak customers of Peoples Gas Light & Coke Co. have been authorized by Illinois Commerce Commission.

The increases will affect eight large industrial users whose service can be interrupted when general demand is high, and 504 customers who get gas only in the summer months. The increases will bring the company $1,481,000 per year in additional revenue.

I.C.C. ordered Peoples to set aside the additional revenue to pay for integration of present facilities with Texas Illinois Pipeline Co.'s line to be completed next year from Texas to Joliet.

Natural Gasoline

Forums Feature Meeting

LOS ANGELES.—Five forums have been added to the fall meeting program of the California Natural Gasoline Association, which will be held here November 9-10.

Each forum will be conducted by a past president of the association, with subjects of particular interest to some phase of the natural-gasoline industry.

The forum leaders and their subjects are: J. B. Taylor, Signal Oil & Gas Co., "The Efficient Operation and Maintenance of Plant Equipment"; C. D. Gard, Union Oil Co., "The Application of Chemical and Process Engineering Principles to the Efficient Design and Operation of Natural Gas Processing Plants"; W. W. Robinson, Jr., The Texas Co., "The Role of the Chemist and Laboratory in Efficient Natural Gas Operation"; M. W. Kibre, General Petroleum Corp., "The Efficient Mechanical Design of Natural Gas Processing and Compression Plants and Natural Gas Gathering and Distribution Systems."

New L.P.G. Barge

To service coastal and inland markets with liquid petroleum gas, Warren Petroleum Corp. is constructing the first barge designed solely to transport the product on the Intercoastal Canal of the Gulf Coast and on inland waterways.

Warren is also extending its facilities by dredging a channel and constructing barge-docking accommodations at the company's L.P.G. terminal on Blakeley Island, Mobile, Ala. Barge-docking facilities already are available at its Norsworthy (Houston) terminal.

Now under construction at the Beaumont, Tex., shipyard of Bethlehem Steel Corp., the barge's delivery is set for early November. Its capacity will be the equivalent of approximately 35 tank-car loads of L.P.G. Six cargo tanks of new multicylinder design will have a combined water capacity of 360,000 gal.

Due to the shallow draft, the barge is designed to service markets far up the waterways of the Mississippi River system.

Propane Contract Awarded

CHICAGO.—A 5-year contract involving an estimated delivery of 28,500,000 gal. of propane has been signed by the Chicago Transit Authority with Phillips Petroleum Co. The fuel purchase is made to service the 500 propane-powered buses recently ordered by the authority, first deliveries of which will begin next month.

C.T.A. has purchased storage facilities from Phillips providing seven tanks of 18,000 gal. capacity each. The contract was let by bid, with Phillips quoting between 8 and 9 cents a gallon for the fuel during the first 2 years. Prices for the last 3 years of the agreement will be based on Phillip's wholesale prices at its refineries.

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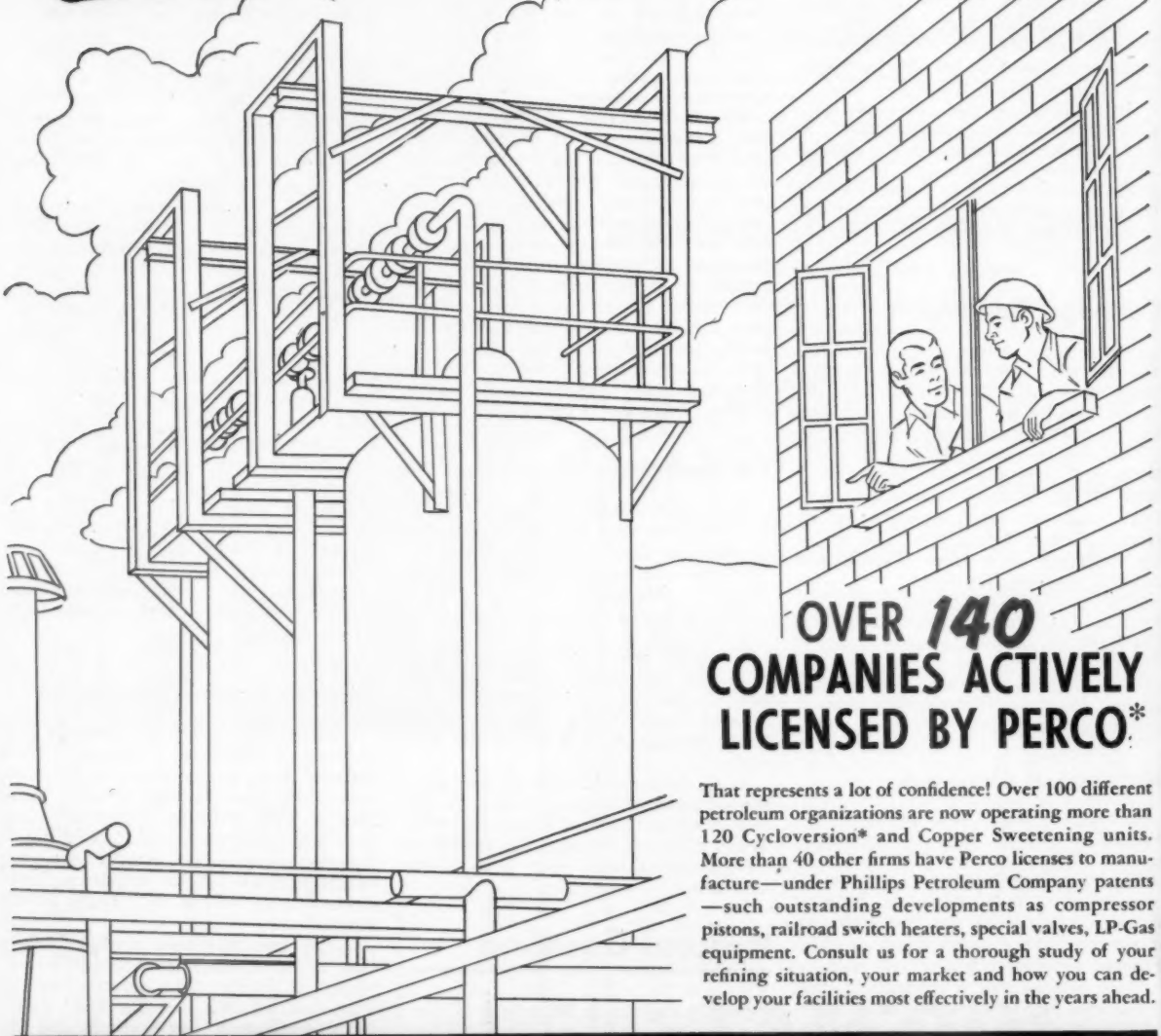

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REFINING

Refinery May Be Reopened

CORPUS CHRISTI.—Pontiac Refining Co. and The Chicago Corp. are discussing with the Government the possibility of reopening the war-built Great Southern Corp. 4,000-bbl. thermal cracking plant here.

Until the time of the Korean war, the two firms had planned to convert the plant into a $15,000,000 chemical and refining unit. They acquired the plant early this year as war surplus on a low bid of $756,000. The firms were scheduled to produce 10,000,000 lb. of ethylene oxide and 60,000,000 lb. of ethylene glycol annually, plus 5,000 bbl. daily of gasoline.

The Chicago Corp. stockholders were told last week that because of "the likelihood of an excess-profits tax, and the possibility that strategic materials will not be available" the conversion plans would be dropped. However, it has been learned it is hoped to reopen at least part of the plant to produce butylene, a raw material for synthetic rubber.

The Great Southern plant produced butylene during and for a short time after World War II. It was shut down for several years before being purchased by Pontiac and Chicago Corp. It is expected that if the plant is reopened the butylene produced will be shipped to the Beaumont-Port Arthur area. U. S. Rubber Co. is in the process of reconditioning the Port Neches synthetic rubber plant in this area. It is reported that the rubber plant will be in full-scale operation before the end of the year.

Humble Closes Texas Plant

HOUSTON.—Humble Oil & Refining Co. has closed down permanently its 7,000-bbl. refinery at San Antonio.

With this move, all Humble refining operations are concentrated at the firm's 260,000-bbl. refinery at Baytown. The San Antonio unit is the last of 10 small refineries which the company has operated during the past 30 years. The small refineries have been shut down as they became uneconomical, according to the company.

The San Antonio refinery started operations in January 1928, and since that time has processed 31,716,000 bbl. of crude and 426,000 bbl. of other raw materials. Approximately 1,969,000 bbl. of aviation gasoline and 8,548,000 bbl. of motor gasoline have been produced and blended during this period.

Future Humble motor-gasoline requirements for the San Antonio area will be supplied from Baytown by pipe line to the newly built San Antonio terminal. Employes at San Antonio were given the option of being transferred to simliar jobs at other locations in the company, taking termination allowances, or retiring where eligible.

This was the second refinery Humble had operated in San Antonio. The old Dixie refinery, at a different location in the area, was operated from 1917 to 1922.

Shell Building New Plant

HOUSTON.—Construction of a new plant for the manufacture of "EPON" resins is under way at the $50,000,000 Houston plant of Shell Chemical Corp. The plant is scheduled to commence operations on or about November 1.

Raw materials for the manufacture of the resins will be primarily petroleum derivatives. "EPON" is the trademark used by Shell to designate a new series of synthetic resins. Various grades of "EPON" resins are used in surface coatings (paints, enamels, and varnishes), in adhesives (for bonding metal, wood, plastics, foam rubber, and a number of other materials to themselves and to each other), and in insulating compounds (as used on fine electrical wiring). Most "EPON" resins are pale amber solids, somewhat similar in appearance to the lighter grades of resins; others have the consistency of thick molasses.

Market demand for this product now requires additional production, according to the company. Initial Houston production will be diverted to the formulation of varnishes and surface coatings.

Du Pont Raises Prices

WILMINGTON, Del.—E. I. du Pont de Nemours & Co., Inc., has announced that prices of its tetraethyl lead antiknock compound will be advanced by about 6 per cent on shipments made on and after October 20.

Higher prices for raw materials, primarily metallic lead, and rising manufacturing costs were cited as chief reasons for the price increase.

The company's action follows by a few days a similar move by Ethyl Corp., in increasing prices of its "Ethyl" brand antiknock compound by approximately 4½ per cent *(The Oil and Gas Journal, September 7, 1950, page 152)*.

Platforming Unit Under Way

ALMA, Mich.—Work has started on a platforming unit at Mid-West Refineries, Inc.'s refinery here which

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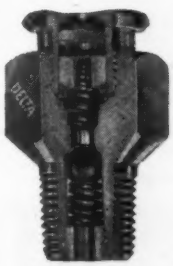

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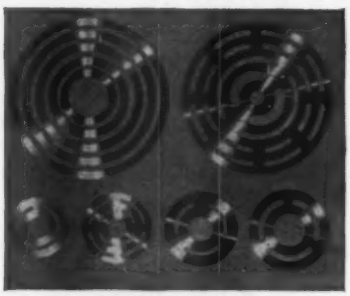

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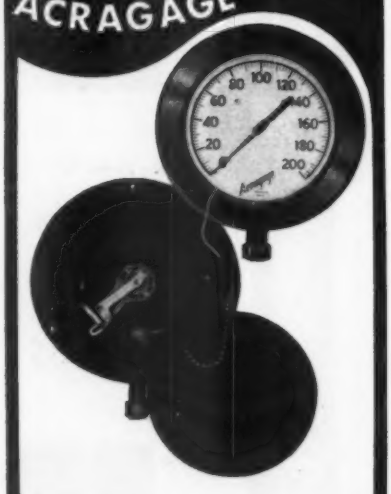

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will produce 1,500 bbl. of high-octane gasoline daily.

Installation of the Universal Oil Products Co. unit is part of an expansion program by Mid-West to meet expanding markets, L. A. Woodward, president, reported. Capacity of the plant will be stepped up from 4,200 bbl. to 10,000 bbl. daily when all work is completed.

The company recently acquired pipe-line facilities through purchase of the Michigan division of Sohio Pipe Line Co., comprising a crude-oil line from Toledo to Central Michigan. The property was acquired by Michigan-Ohio Pipeline Corp., a Mid-West subsidiary.

Saskatchewan Cat Cracker

MOOSE JAW, Sask.—The first catalytic cracking unit in Saskatchewan will be installed at the Moose Jaw refinery of British American Oil Co., Ltd.

Projected development also includes the installation of a coking plant, a thermal cracking unit, and catalytic polymerization equipment. Several million dollars have been appropriated for the expansion.

Present construction schedule calls for the completion of the expansion program not later than January 1952. When in operation it will increase capacity of the present refinery from a daily level of 6,000 bbl. to 10,000 bbl.

The enlarged facilities will boost the refinery's gasoline production from 115,000 gal. daily to 227,000 gal.

Sohio Lets Contract

CLEVELAND.—Standard Oil Co. of Ohio announced this week that it has let a contract to Arthur G. McKee Co. for construction of a $5,500,000 crude-oil distillation plant at its No. 1 refinery here.

The plant will include two complete units, each capable of running 22,500 bbl. of crude oil daily. In addition, improvements will be made in existing vacuum distillation equipment.

Construction will begin early next year, with completion scheduled for November 1951.

The expansion of production equipment is part of Sohio's continuing modernization program. It is in addition to the $4,000,000 catalytic cracking unit already under construction at the No. 1 refinery.

Richardson Plant Operating

HOUSTON.—The 25,000-bbl. Texas City refinery of Sid Richardson Refining Co., which was closed for 14 months, is now operating at about 50 per cent capacity. The plant was reopened September 1, and 110 workers are now back on the job. John Allen, superintendent, said it is not known when the refinery will reach full-capacity operation.

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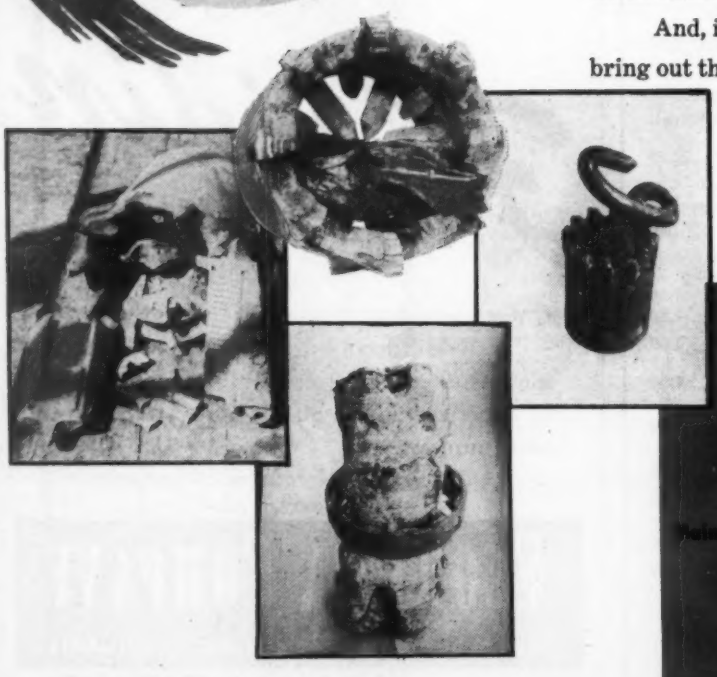

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Among the Drilling Contractors

ROTARY RIGS IN OPERATION*

(United States and Western Canada)

Area—	Week ended 9-11-50	Change week ended 9-4-50	Change week ended 9-12-49
Gulf Coast	526	+ 4	0
W. Tex.-N. M.	770	+38	+225
Ark.-N. La.-E. Tex.	136	— 6	— 12
Oklahoma	278	— 3	+ 54
Kansas	132	+ 5	+ 19
Illinois-Eastern	116	+ 4	0
Rocky Mountains	126	+ 6	+ 17
Pacific Coast	136	— 5	— 17
Total U. S.	2,220	+43	+286
Western Canada	96	— 3	+ 26
Total	2,316	+40	+312

*Courtesy Hughes Tool Co. Trends in drilling activity in the United States and the Gulf Coast and Arkansas-North Louisiana-East Texas areas are shown by charts on pages 410 and 411.

Barnwell Drilling Co. is the contractor on a Paluxy sand test being started 1½ miles southeast of the Grand Cane field, DeSoto Parish, North Louisiana, by Lyons, Printiss & McCord. The test is 1 Chaffin. Its location is in the SW SW SE 4-12n-14w.

Tools of **Lowell & Gist** are being used in drilling General Petroleum Co. 88-9 Patented, SE SE SE 9-6n-21w, an outpost test in Moffat County, northwestern Colorado. Hole is projected to 8,700 ft. for a test of the Sundance sand.

Southeastern Drilling Co., Dallas and Jackson, Miss., has the contract for a 15,000-ft. test (1 Cameron) to be drilled for Continental Oil Co. in the area 7½ miles northwest of Canton, Madison County, Mississippi. Location is in the C SE SW 36-10n-12. Objective is the Smackover lime.

Deep Fork Drilling Co., Tulsa, is drilling for Wilcox Oil Co. at 1 Focht, a wildcat test in the NE SW NW 20-19n-3e, 2 miles east of Stillwater, Payne County, Oklahoma.

Longhorn Drilling Corp., San Antonio and Three Rivers, Tex., has the contract for drilling an 8,750-ft. test for Argo Oil Corp. of Denver in the Maxine gas-distillate area, Live Oak County, South Texas. The test will be 1 Kitty West Schreiner. Location is in Lot 409, Block B, George West ranch. This contractor also is drilling a 12,000-ft. test for Western Natural Gas Co. on the St. Charles ranch in Aransas County, Texas Gulf Coast. Toolpusher on the latter job is Clem Nolan.

Falcon Seaboard Drilling Co. Tulsa

Currently operating 17 rotary rigs, Falcon Seaboard Drilling Co., with headquarters at Tulsa, is one of the larger and more active companies in the contracting business. It also has extensive acreage holdings and sizable oil production of its own. Present operations and holdings are spread over four states, Kansas, Oklahoma, Texas, and Louisiana. Divisional headquarters for the Gulf Coast region are located at Houston.

THEODORE N. LAW

History.—The company had its beginning late in 1935. Originally, it was known as the Falcon Drilling Co. Later, when operations were extended from the Mid-Continent area to the Gulf Coast region, the word "Seaboard" was inserted in the name. At is inception, the company had three rotary rigs. An additional rig was acquired soon. To date, the company has drilled more than 600 wells.

Organizers.—Organizers included the present top executives. They are: Theodore N. Law, president; J. L. Stauss, treasurer and vice president in the Tulsa division; and C. W. Alcorn, vice president in charge of the Gulf Coast division with headquarters at Houston. They were assisted actively in the early development of

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the company by F. E. Bernsen, president of Lucey Products Co., Tulsa.

Law, a great grandson of the late William Barnsdall, founder of the former company bearing his name, was brought up in the oil business, and has been actively engaged in it for more than 20 years. Stauss' first experience in the oil business, dating from the time he completed school, was in the accounting and financial phases. His activities later spread to field and production work. He now divides his time between supervision of rigs in the company's Tulsa division and financial management. Alcorn, who has worked in oil fields of Oklahoma, Texas, and Louisiana ever since he got out of school, was assistant superintendent of production in Texas, Arkansas, and inland Louisiana for Shell Oil Co. prior to formation of the drilling company.

Management.—In addition to the above, top management personnel includes: S. H. Johnson, secretary and managing co-ordinator for the Tulsa and Houston divisions; C. M. Bailey, assistant secretary; J. O. Brown, general manager of production; S. L. Kennedy, assistant manager, Houston division; Harry Smith, production superintendent; W. E. Williams, assistant production superintendent; and Howard S. Kunsman, director of geological activities. All have long terms of service, ranging from 7 to 13 years, with the company.

Affiliates.—The company owns 50 per cent of Falcon Seaboard of Canada, Ltd., Calgary, Alta. The latter company, organized in May 1949, is operating three rotary rigs in western Canada. F. Frank Bridges is president and resident manager; Stauss, in addition to his position with the Tulsa company, is vice president. Ray Tull is drilling superintendent, and F. L. Tull and E. H. Farmer, assistants.

Special achievements.—Never in all its 15 years of operation has the company had a fatal accident. For its record of no fatalities during the 10-year period from January 1, 1940, to January 1, 1950, the company has just been awarded the Joseph A. Holmes Safety Association "Certificate of Honor." Formal presentation of the award will be made at the annual meeting of the American Association of Oilwell Drilling Contractors at Tulsa October 9-10.

Montgomery Drilling Co., El Dorado, Ark., has a rig working for Don Montgomery, one of its owners, and associates on a projected 4,000-ft. test located in 35-17n-9e, a mile south of the Delhi field, Richland Parish, northeastern Louisiana.

R. P. Phillips, Lafayette, La., is the contractor on a 5,000-ft. test being started by Alfred Lamson and Sam Bennett 3½ miles east and a little north of Trilby, Acadia Parish, coastal Louisiana. The test is 1-B August Leonards. Location is in 29-7s-1e.

Kenneth Manion, Houston, will drill a deep test for Ryan, Hays & Burke at 1 Leon Bromberg, Section 486, Block 1, ELRR Survey, a wildcat location 5 miles southeast of Tahoka, Lynn County, West Texas.

Gabbert & Jones have a rig on a wildcat location, 4 miles north of the North Wherry pool, Rice County, Kansas, where they are drilling for S. E. Likins at Burge, SE SE SW 12-20-7.

Thomas H. Allan, Wichita, is drilling for H. A. Hutchins at the latter's 1 Fee, NW SW SE 22-20-8, 1½ miles northwest of the Union gas pool, Rice County, Kansas.

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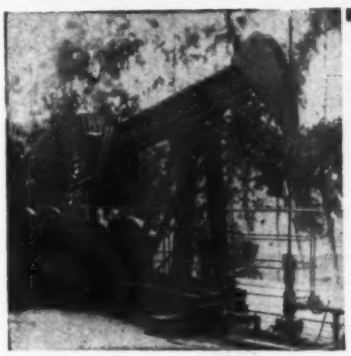

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Exploration and Drilling

Terry County Is Not Another "Scurry"

REEF production has been found at several points in the eastern two-thirds of Terry County, Texas, along a "trend" that arcs west and then northward from the southern end of the Scurry County fields. However, limited data on the age and water levels of the reef buildups in Terry County so far accumulated do not indicate that Scurry County's conditions of reef buildup were duplicated in Terry.

This does not mean that the reef production already found in Terry County, or that which will doubtless be found in the immediate future, will not be as profitable for operators as that found in Scurry County. In fact, due to evidence of active water drive in the Terry reef reservoir, individual operations may prove to be more profitable than those in the Scurry area which has shown large pressure declines in the bigger producing sections. To say that Terry County is not another "Scurry" means only that an area of essentially contiguous production at all comparable in size to Scurry County's massive field does not appear probable in county to the west.

In Scurry County, ideal conditions for reef buildup (rate of relative subsidence of the ocean floor, depth, salinity, and temperature of the sea water, etc.) existed throughout an enormous area (over 100 square miles) on an Ellenburger terrace or regional nose during Pennsylvanian time. Similar conditions ideal for reef buildup also existed in Terry County during Canyon time, but only locally. (Indications are that the areas of ideal conditions for reef buildup in Terry County are associated with Ellenburger structures). However, the reef buildup in Terry County, instead of being restricted to Canyon time as in Scurry, continued on through Cisco time and into lower Permian-Wolfcamp time, so that tremendous pinnacle-like buildups resulted in places.

Wellman pool, opened last July by Anderson-Prichard Oil Corp. 1 Bevers, in the south-central part of Terry County, is located on an Ellenburger structure of considerable magnitude. Here the reef, lithologically indistinguishable from Scurry's Canyon reef, has been identified as of Wolfcamp age by paleontologists. The reef was topped at 6,433 ft. subsea, and was found to be oil-saturated for a little over 100 ft. with no sign of water to total depth.

Shortly after Anderson-Prichard's discovery, Amerada Petroleum Corp. 1 Willard, now drilling for pre-Pennsylvanian horizons about 1 mile north of the Permian (San Andres) producing Adair field, located about 6 miles to the southeast of the Bevers, topped the reef at 5,245 ft. subsea. Many observers interpreted the nearly 1,200-ft. difference on the top of the reef between the 1 Bevers and the 1 Willard to mean that Anderson-Prichard's well was on the edge of a tremendous reef buildup. Leases and mineral interests between the two discovery wells sold for fabulous prices, and then, after drilling only 60 ft. into the reef, Amerada's well hit water. This can only be interpreted to mean that there is a saddle over 1.200 ft. deep between the two pinnacles of reef buildup.

The estimated productive reef area in Scurry County, which has an essentially constant water-table datum, is continuous for 35 miles. Terry County does not have such a continuity of reef water level as emphasized by the Wellman-Adair area, and other wells throughout the eastern portion of the county. Union Oil Co. 1 Cotten, about 3 miles north and east of the 1 Sawyer, topped the reef at 6,648 ft. subsea and found it oil-saturated to total depth at 6,918 ft. subsea. The discovery well of Mound Lake pool, Seaboard Oil Co. 1 Hinson, found water in the reef at 6,186 ft. subsea. Stanolind Oil & Gas Co. 1 Sawyer, located about 6 miles northeast of Wellman pool, topped the reef at 7,061 ft. subsea, and found water right in the top of it.

There are a number of wildcats and pool confirmation wells now being drilled in Terry County's hot play. Of special interest are the four offsets to Anderson-Prichard 1 Bevers, at least one of which will be carried to the Ellenburger, and Placid Oil Co. 1 Van Rosenberg, a wildcat to the southwest of this cluster of wells. There are three drilling offsets to Union 1 Cotten. Near Mound Lake, which has two producing wells, Houston Oil Co. et al 1 Hinson and Champlin Oil Co. 1 Lindsley are drilling. C. L. Norsworthy, Jr. 1 Hulme is a wildcat north and west of Brownfield townsite. East and north of Union 1 Cotten is another wildcat, Ohio Oil Co. 1-A A. R. Brownfield, which is being watched with considerable interest.

Philip C. Ingalls.

HIGHLIGHTS OF WEEK'S DEVELOPMENTS

SOUTH LOUISIANA.—A new pay and extension to Turtle Bayou field, Terrebonne Parish, has been completed at Shell Oil Co. 3 Continental Land & Fur Co., C NE SE 28-17s-14e, 1½ miles northeast of the field discovery well. It flowed 325 bbl. of 33°-gravity oil daily through perforations at 6,514-34 ft. The pool opener flowed 65 bbl. of 47.5°-gravity distillate per day through perforations at 11,980-88 ft. (See following field report this issue).

WEST TEXAS.—Magnolia 1 H. S. Collings, Section 7, M. Daugherty Survey, confirmation well for the Parks Ellenburger discovery in Midland County, recovered 240 ft. of free oil on a drill-stem test at 10,045-10,123 ft. in the Pennsylvanian. The 2 Roy Parks, discovery well, had good oil shows in the Pennsylvanian. In Kent County, Star Oil Co. 1 Blanche Young, 54-5-H&GN, 11 miles southwest of Salt Creek field, found shows of oil in sample returns at 7,188-7,214 ft., tentatively identified as Pennsylvanian, but a drill-stem test recovered mud with no shows.

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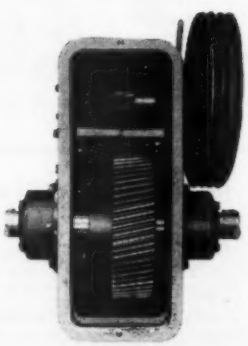

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Texas Gulf Coast

Northern Brazoria Wildcat Has Rumors of Production

HOUSTON.—Floyd L. Karsten 1 Richard W. Sharp et al, wildcat test 5 miles southeast of Arcola, Brazoria County, is reported (unconfirmed) to have flowed an estimated 200 bbl. of oil through a ¼-in. choke with 1,600 psi. pressure on the tubing, on a test of the lower Frio. The well was drilled to a depth of 8,765 ft. and operator set 7-in. casing at 8,233 ft. with 5-in. liner run to bottom. If this report is correct, the well topped the Frio high, as it was expected around 8,900 ft. Location is in the J. S. Talmadge Survey, Abstract 561. The same operator is reported to be moving approximately ¼ mile northeast of the 1 Sharp to stake a new location.

New pay has been opened in Columbus field of Colorado County, at Cities Service Oil Co. 3 John Schobel, which was completed as a dual gasser for a total of 27,300,000 cu. ft. of gas per day. Through perforations at 9,471-91 ft., the well flowed 21,000,000 cu. ft. of gas per day on open flow, having a shut-in pressure of 3,224 psi. Casing completion was made in the upper sand from 9,260-80 ft., which produced 6,300,000 cu. ft. of gas daily on open flow, with a shut-in pressure of 3,365 psi. The well is in the Tumlinson Survey, 5 miles northwest of Columbus townsite.

H. J. Porter is starting a second test on his Yaussi "B" lease on the west flank of Cordele field, Jackson County, as his first well is completing for oil production through perforations at 3,205¼-22 ft. Initial production test of this zone was unsatisfactory as water broke in on the formation, and operator squeezed and reperforated for completion. A drill-stem test farther up the hole at 2,789-92½ ft. showed oil, and sidewall cores recovered oil saturation at 3,048-54 ft. A total of eight oil and gas sands are reported on the structure, which is separated from the field by faulting.

Sunray Oil Corp. has perforated its 1 Dillworth, wildcat 5 miles northeast of Oakville, Live Oak County, at 7,543-57 ft. The discovery prospect was drilled to a depth of 7,565 ft. and operators set 5½-in. casing to 7,600 ft. for completion attempt. A number of interesting cores were taken during the drilling. Gas-condensate sands were tested from above 7,100 ft. to below 7,200 ft., and other sands with oil and gas shows were cored down to the 7,600-ft. level. Location is in the Refugio County School Land Survey, Abstract 398.

TEXAS GULF COAST (DISTRICTS 2 AND 3) WILDCAT FAILURES

Austin County: Commercial Petroleum & Transport Co. 1 Henry Huber, James Cummings League, A-31, 4 mi. SW Bellville, dry, TD 10,665 ft.

Magnolia Petroleum Co. 2 Joe Vitek, S. F. Austin League, A-7, W flank San Felipe Dome, dry, TD 9,303 ft.

Chambers County: Sun Oil Co. 1 Brandt, Henry Barker Sur., 2,100 ft. SE Galveston Bay shore, dry, TD 12,506 ft.

Galveston County: John M. Mecom 24 E. Ker Cade et al, W flank High Island, W. M. Hudson Sur., dry, TD 7,200 ft.

Goliad County: Sun Oil Co. 1 George A. Ray, W. D. Sutherland Sur., ¾ mi. NW Hord's Creek field, dry, TD 8,074 ft.

Hardin County: M. T. Halbouty and Texas Co. 1 A. Merchant, Stephen Jackson Sur., A-34, NE flank South Lake, dry, TD 3,434 ft.

Harris County: L. M. Josey 1 H. T. Williamson, H&TC Sec. 19, A-428, 5 mi. SW Cypress, dry, TD 7,809 ft.

Jefferson County: Commercial Petroleum & Transport Co. and Crown Central Petroleum Corp. 1 R. H. Hunter, T&NO RR Sur. 24, A-650, 8 mi. SW Beaumont, dry, TD 8,302 ft.

Karnes County: Rowan & Hope 2 A. & L. Schorre, Carlos Martinez Gr., A-6, 4 mi. S Runger, dry, TD 7,008 ft.

Lavaca County: H. R. Goodrich & W. H. Cocke 1 Albert Pohl, Moses Wooten Sur., A-496, 4 mi. SW Vienna, dry, TD 5,543 ft.

Liberty County: Josey-Nelms-Halbouty 2 Myrtle Chambers, M. G. White League, South Liberty area, dry, TD 3,589 ft.

Matagorda County: Skelly Oil Co. Edna Roades, Maria Cummins League, 4 mi. NE Bay City, dry, TD 12,582 ft.

Polk County: Dr. S. H. Bergman et al 3 Ernest Coker, John T. Pickney Sur., A-63, 2½ mi. N Goodrich, dry, TD 3,690 ft.

Refugio County: T. G. Benson 1 R. M. Hardsdorff, Antonio de la Vina Gr., A-71, 1 mi. SW Boodsboro field, dry, TD 6,015 ft.

South Louisiana

Turtle Bayou Stepout Also Finds New Pay

NEW ORLEANS. — Shell Oil Co. has opened a new oil sand and extension 1½ miles northeast of its Turtle Bayou field discovery in Terrebonne Parish, at its 3 Continental Land & Fur Co., C NE SE 28-17s-14e. Through 12/64-in. choke, the well flowed 325 bbl. of 33°-gravity crude plus 1,516,000 cu. ft. of gas per day. Tubing pressure was 2,950 psi. and gas-oil ratio 4,356 to 1. Hole is bottomed at 12,758 ft. and production is through perforations at 6,514-34 ft.

Turtle Bayou was discovered by Shell in November 1949, at its 1 Continental Land & Fur Co., C NW SE 32-17s-14e. This well flowed 65 bbl. of 47.5°-gravity distillate and an estimated 2,749,000 cu. ft. of gas per day through a 12/64-in. choke. Production was through perforations at 11,980-88 ft.

Gas-distillate production is indicated at Abbeville field, Vermilion Parish, in the lower Miocene section as tests get under way at Continental Oil Co. 1 Noah P. Harrington, which is bottomed at 12,523 ft. Operator cemented 5½-in. liner to 11,112 ft. and perforated the pay zone from 11,029-35 ft. for test. On an 11-hour test, the well flowed 9 bbl. of distillate through a 3/16-in. choke, and produced gas at the daily rate of 3,044,000 cu. ft. The well is located on the easterly side of production in 67-12s-3e. Abbeville has, heretofore, been an oil producing field from around 6,500 ft.

Sun Oil Co. and Sohio Oil Co. are preparing to begin testing operations at 1 Le Blanc, wildcat test 1¼ miles southeast of Midland gas-distillate field. Sun discovered the field at its 3 Lapleau, which is producing through perforations at 10,618-30 ft. The 1 Le Blanc is reported to have encountered gas at about 11,585 ft., indicating either a new sand for the area or a field extension.

In Acadia Parish, Alfred Lamson and Sam Bennet have released no information on their 1 August Leonards, 29-7s-1e. However, at last report, they were running 5½-in. casing at total depth of 4,564 ft. in the wildcat. Indicating that they have found production in the well, the same operators have staked location for their second well in the area, which is designated as a 1 August Leonards "B."

SOUTH LOUISIANA SUCCESSFUL WILDCAT

Terrebonne Parish: Shell Oil Co. 3 Continental Land & Fur Co., 1½ mi. NE Turtle Bayou production, perf. 6,414-34 ft., TD 12,758 ft., 325 bbl. oil per day, 12/64-in. choke, TP 2,950 psi., 33° gravity.

SOUTH LOUISIANA WILDCAT FAILURES

Beauregard Parish: Bateman Drilling Co. 1 Lutcher Moore Lumber Co., 2-7s-12w, dry, TD 9,137 ft.

Rapides Parish: Carter Oil Co. 1 Hardtner-Tanne-Hill, 6-5n-3e, 3 mi. N and 2 mi. E Holloway, dry, TD 6,005 ft.

St. James Parish: Texas Co. 2 Miles Timber

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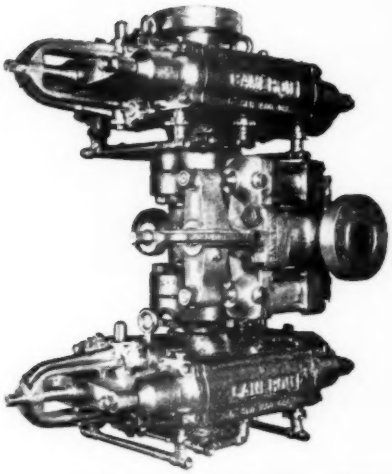

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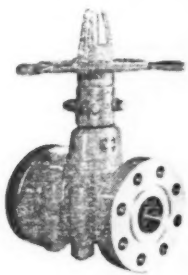

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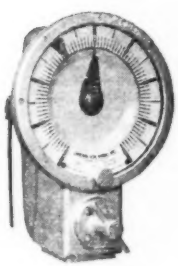

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Co., 26-13s-17e, 5 mi. S and ½ mi. E St. Patricks, dry, TD 7,500 ft.

West Baton Rouge Parish: Humble Oil & Refining Co. 1 W. H. Forman et al, 1½ mi. S and 2 mi. W Lobdell townsite, dry, TD 11,400 ft.

Southwest Texas

Gonzales County Strike Continues Flow Tests

CORPUS CHRISTI. — Producers Corp. of Nevada is making flow tests of its highly important new discovery in Gonzales County. The company's 1 Hellen Williams et al flowed 24.8°-gravity oil at the rate of 33 bbl. per hour through ¼-in. choke, on a 3-hour preliminary test. Later, it flowed 7 bbl. per hour through a 9/64-in. choke, with tubing pressure of 600 psi. and casing pressure of 550 psi. Apparently production is from the Georgetown lime in open hole at 5,803-5,940 ft., with the hole plugged back from total depth of 5,964 ft. in the Edwards lime. It is believed that the discovery opens a new trend of production down-dip about 30 miles from the old Balcones fault zone fields. It lies 3½ miles north of the town of Nixon, in the southwest part of Gonzales County, William C. Hargis Survey, Abstract 273.

A new deep oil horizon is being opened in Amargosa field of Jim Wells County, just north of Alice, at George W. Graham et al 1 Lester Moore. On initial production test through perforations at 5,986-92 ft., the well flowed oil and salt water. These perforations were squeezed and operator reperforated at 6,985-90 ft. for completion in the new zone. Another productive sand was indicated in the well at 5,749½-55 ft., when gas and condensate were recovered on drill-stem test.

New pay is being opened in Sinton field of San Patricio County at Billy Bridewell and W. G. Darsey, Jr. 1 S. J. Lewis. The well came in flowing 172 bbl. of pipe-line oil per day through a 5/32-in. choke with 600 psi. tubing pressure and 800 psi. casing pressure. Total depth of the well is 5,312 ft. It is located in Farm Lot 32, M. J. de la Garza Survey.

Also in San Patricio County, La Gloria Oil Corp. 1 J. H. Harvey, Harvey field area wildcat, is drilling ahead at 8,445 ft. after recovering oil on a series of drill-stem tests in two sands. On a 20½-minute drill-stem test at 8,250-67 ft., recovery was 700 ft. of 40.1°- gravity oil and 120 ft. of salt water. Bottom-hole pressure was 3,325 psi. On a 25½-minute test at 8,368-78 ft., recovery was 90 ft. of 47°-gravity oil. Bottom-hole pressures were 2,925 psi., flowing, and 3,675 psi. shut in.

SOUTHWEST TEXAS (DISTRICTS 1 AND 4) WILDCAT FAILURES

Bell County: Pryor Dillard 1 Mary T. Whatley, Jose David Sanches Six League Gr., 12 mi. SE Temple, dry, TD 2,840 ft.

Owen Hembree 1 A. D. Parrott, M. A. Britton Sur., A-99, 1½ mi. NE Moffat, dry, TD 1,321 ft.

Bexar County: Rollin V. Hill 1 Calvin Hawkins, Jose N. Meatea Sur. 59, 14 mi. SE San Antonio, dry, TD 1,812 ft.

Caldwell County: W. Calbach 2 Kelly, E. Pettus Sur., 3 mi. NE Lockhart, dry, TD 1,947 ft.

Miller-Wells, Inc. 1 C. W. Baker, Moses Gage Sur., 7 mi. NE Lockhart, dry, TD 3,077 ft.

Duval County: Argo Oil Corp. 6 John M. Bennett, Jr. et al, CEPI&M Sur. 40, 5½ mi. SW Driscoll field, dry, TD 4,010 ft.

Holly Development Co. and Barbara Oil Co. 25 Driscoll est., Block 66, Santa Rosalia Rafael Ramirez Gr., A-476, dry, TD 3,775 ft.

R. Thos. McDermott 1 Rosendo Lopez, F. Lopez Sur. 55, A-1863, 12 mi. NE Bruni, dry, TD 2,951 ft.

Guadalupe County: Sam H. Harper and

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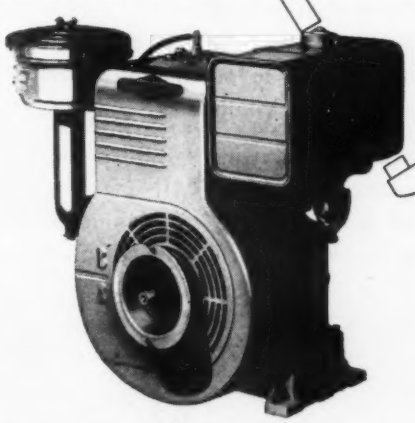

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W. J. Worsham 1 R. O. Lively, Joseph Kent Sur., 6 mi. SE Seguin, dry, TD 2,173 ft.

Sam H. Harper and W. J. Worsham 1 B. R. Ussery, William G. Hunt Sur., A-149, 1 mi. E Kingsbury, dry, TD 2,405 ft.

Hidalgo County: Continental Oil Co. 1 Woods Christian, La Reforma area, 7 mi. SE Delmita, San Ramon Gr., Rich Ranch Blk. 104, Share 16-A, dry, TD 7,617 ft.

Kimble County: Anzac Oil Corp. 1 Lottie Bolt et al, Joseph Dafner Sur. 58, A-336, TD 1,850 ft.

Medina County: C. E. Smeltz 2 Mrs. M. Adams, Edmund C. Durst Sur. 13, 14 mi. W Devine, dry, TD 429 ft.

Nueces County: Selby-Walker Corp. and Ryan, Hays & Burke 1 George Faske, Bishop Subd. of Driscoll Ranch, 4½ mi. SE Bishop, dry, TD 7,505 ft.

San Patricio County: H. H. Howell 1 C. S. Brown et al, Lot 16, Summers Subd. in M. P. & J. N. Delgado Gr., A-4, dry, TD 5,440 ft.

A. O. Morgan B-1 Louse Neumann, Lot 9, Bullard Subd. of Burgess Sur., 3 mi. NW of Odem, dry, TD 7,537 ft.

H. R. Smith and Champlin Refining Co. 1 Mrs. Ella Svadlenak, Sec. 52, G. H. Paul Subd. of Coleman-Fulton Pasture Co. land, 5 mi. SW Taft, dry, TD 6,254 ft.

Union Oil Co. of California 1 R. H. Welder, West Taft area, H. O'Neill Sur., A-210, 4 mi. NW Taft, dry, TD 6,428 ft.

Starr County: Ben D. Marks, Tr. 1 Marrs McLean, Juan Flores Gr., 5 mi. W Cuevitas field, dry, TD 2,315 ft.

Travis County: B. W. Trull 1 Alfred Carlsson, Lemuel Kimbro Sur., 5 mi. NE Manor, dry, TD 1,090 ft.

Webb County: Floyd L. Karsten 1 A. E. Gates, Horace L. Baker Sur., 15 mi. W Freer, dry, TD 8,402 ft.

Wilson County: W. E. Field and A. A. Lutenback 1 J. C. Rodriguez, Vicente Sepada Sur., A-23, 2 mi. SW Saspamco, dry, TD 3,704 ft.

Zapata County: Don H. Marsh et al 1 Eleuterio Lopez, S. C. Hendricks Sur. 288, Cert. 1,383, 36 mi. SW Hebbronville, dry, TD 1,053 ft.

Appalachian Field

Cabot Stakes New Well In Leidy Pa., Gas Area

PITTSBURGH.—A new location has been made in Leidy Township, Clinton County Pennsylvania, by Godfrey L. Cabot, Inc. 1 Laura Jacobus, elevation 1,292 ft., on the Tamarack Quadrangle. No completions were reported in the past week in this area. In southwest Pennsylvania, Unity Township, Westmoreland County, Peoples Natural Gas Co. 1-3921 Fred Musnug, elevation 2,100 ft., is drilling at 5,600 ft. In Napier Township, Bedford County, South Penn et al-Snee & Ebery 1 Jesse B. Miller, elevation 1,66 ft., is fishing at 7,640 ft.

In the Limestone Hill area, Steele district, Wood County, West Virginia, United Carbon Co. is spudding in 1-1740 Wattie R. Ayers, elevation 846 ft. It is on the Belleville Quadrangle .30 mile south of Lat. 39°, .05′, and 2.30 miles west of Long. 81°, 30′. Columbian Carbon Co. 1-GW-1153 Godfrey L. Cabot, Inc. (J. H. Stephens tract), elevation 809 ft., gaged 15,107,000 cu. ft. of gas. The following tops were reported: Corniferous lime 4,902 ft., Oriskany sand 5,018 ft., gas 5,019-32 ft. Total depth was 5,032 ft. The initial rock pressure was 1,050 psi. in 96 hours. This company's 1-GW-1149 S. M. Wigal et al, elevation 1,071 ft., resulted in a dry hole, topping Corniferous lime at 5,230 ft., Oriskany sand at 5,343 ft., with total depth of 5,431 ft.

WEST VIRGINIA SUCCESSFUL WILDCAT

Wood County, Steele district: Columbian Carbon Co. 1-GW-1153 Godfrey L. Ca-

bot, Inc. (J. H. Stephens tr.), elev. 809 ft., 15,107,000 cu. ft. of gas from Oriskany at 5,019-32 ft., TD 5,032 ft.

WEST VIRGINIA WILDCAT FAILURE

Wood County, Steele district: Columbian Carbon Co. 1-GW-1149 S. M. Wigal et al, elev. 1,071 ft., dry, TD 5,431 ft.

Michigan

Gas Pay Tapped In Wildcat Test

MOUNT PLEASANT.—Louis Rose 1 Bittner, NW SW SE 19-17n-10w, Richmond Township, Osceola County, was the most closely watched wildcat test in Michigan at mid-week as Dundee top was checked in structurally high and a top Dundee gas pay, which was gaged at 70,000 cu. ft., had been drilled.

Top of Dundee was logged at 3,601 ft., from 10 to 43 ft. higher than correlating dry-hole tests. The gas pay was showing at 3,604 ft. The 1 Bittner wildcat is located about 2½ miles south of the big Reed City oil pool.

A later report indicated that water had been logged in the Dundee and hole was being drilled ahead towards the Reed City zone which had carried good oil shows in other wells in the area.

The dry hole which is being used as the best check on this current test is one drilled by H. E. Bell in the NE NE SE 30-17n-10w, which was reported to have carried a near-commercial oil pay in the Reed City zone. Bell's test was about 13 ft. lower on the Dundee than the Rose wildcat. Bell also was reported to have logged a show of gas in the Dundee.

A Traverse oil show was under test at Kisner & Laue 1 Worst Estate, NE NE NE 32-4n-13w, Salem Township wildcat, Allegan County, where 1,100 ft. of fluid, 700 ft. of which was oil, showed in 16 hours at 1,658-60 ft. Top of Traverse lime was picked at 1,657 ft. A string of 5-in. casing was being run in preparation for further testing.

The Salem wildcat well is located about 2 miles south of the original Salem Traverse oil pool and about the same distance north and east of Diamond Springs Traverse oil field.

MICHIGAN SUCCESSFUL WILDCAT

Allegan County, Allegan Township: Sheldon-Stewart Co. 1 Flynn, SW SE NE 13-2n-13w, Traverse 1,519 ft., 2 bbl., TD 1,523 ft.

MICHIGAN WILDCAT FAILURES

Allegan County, Casco Township: Ford Oil Co. 1 Sankofski, SW NW NE 1-1n-16w, Traverse 1,190 ft., dry, TD 1,197 ft.

Monterey Township: Pascal F. Broughton 1 Gowens, SW SE SE 31-3n-13w, Traverse 1,472 ft., dry, TD 1,485 ft.

Valley Township: The Ohio Oil Co. CT A-49 U. S. A., SE SW NE 29-2n-14w, Traverse 1,327 ft., dry, TD 1,342 ft.

Mecosta County, Austin Township: Michigan Consolidated Gas Co. 1 Marek, C NW 23-14n-9w, Stray 1,356 ft., dry, TD 1,372 ft.

Ogemaw County, Rose Township: Union Development Co. 1 State-Rose, SE NE NE 14-24n-3e, dry in Richfield, TD 4,495 ft.

Osceola County, Highland Township: Granville C. Berlin 1 Morred, SE SE NW 19-20n-8e, Monroe 4,282 ft., dry, TD 4,360 ft.

Saginaw County, Fremont Township: C. W. Collin 1 Lang, NW NE SW 6-11n-2e, Dundee 3,150 ft., dry, TD 3,225 ft.

Van Buren County, Geneva Township: Cook Drilling Co. & A. J. Gilmore 2 Hammond, NW SE NE 1-1s-16w, dry in red rock, TD 545 ft.

Pine Grove Township: Augie Busk 1

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Hrabacka, SW NW SW 3-1s-13w, Traverse 1,345 ft., dry, TD 1,367 ft.

Porter Township: W. D. Gannett 1 Gibson, NW SE NE 17-4s-13w, Traverse 1,176 ft., dry, TD 1,200 ft.

North Central Texas

Skelly Has Show In Stonewall County

WICHITA FALLS.—Skelly Oil Co. 1 C. Hamilton, southeast offset to Roark, Hooker & Hill's 1 Williams, Bend conglomerate discovery 8 miles northeast of Aspermont in Stonewall County, recovered 7 ft. of Mississippian limestone, bleeding oil, gas, and water. Core was taken from 5,912-26 ft. and operators were preparing to drill-stem test the section.

Location of the 1 Hamilton is 467 ft. out of the northeast corner of the A. M. Reed Survey. On elevation of 1,631 ft., Skelly 1 Hamilton had top of the Caddo lime at 5,755 ft., or minus 4,124 ft.; and the discovery, 1 Williams, had the Caddo at 5,745 ft., or minus 4,133 ft.

Skelly's well also showed for production from the conglomerate, having flowed 20 bbl. of oil in 45 minutes on a drill-stem test from 5,899-5,910 ft.

Drilling was under way at R. J. Caraway and T. D. Humphrey 1 John Behringer, Ellenburger wildcat located 1½ miles east of Roark, Hooker & Hill's discovery. Location is 467 ft. out of the southwest corner of a 316-acre tract in the G. B. Cooke Survey.

Rowan & Hope 1 Catherine Berry, 217-D-H&TC, 6 miles northwest of Swenson and 5 miles northeast of Carlile field, Stonewall County, had top of the Ellenburger at 6,476 ft. and was drilling ahead to the Hickory sand at 6,610 ft. A drill-stem test from 6,460-6,521 ft. recovered 90 ft. of mud in 1 hour.

In northwest Grayson County, L. O. McMillan and J. R. & Adam Seitz made location for their 1 Allen F. Marshall, a semi-wildcat ½ mile east of Sandusky in the B. Scarborough Survey, A-1,421, and an east offset to McMillan's 1 Chambers, recent Oil Creek sand discovery. Location of the new well is 550 ft. from west and 467 ft. from north lines of lease, or 467 ft. from north and 900 ft. from west lines of survey.

Jones-McFarland & O'Connell, Dallas operators (formerly Jones-Simpson Drilling Co.), filed application to drill a 6,500 ft. wildcat 1½ miles south of Rogers & Rogers field in north-central Montague County. Location was 3,025 ft. from west and 1,650 ft. from north lines of the A. Buffington Survey, A-31, and 1 mile south of Nocona.

NORTH TEXAS (DISTRICTS 9 AND 7-B) SUCCESSFUL WILDCATS

Coleman County: Cecil T. Weaver 1 L. M. Weaver, Sec. 16, A. Gable Sur. 271, 7 mi. NE Coleman, TD 1,852 ft., pay 1,813 ft., pumped 15 bbl. 41°-gravity oil.

Comanche County. J. K. Wadley and D. Breeding 1 J. F. Reed, Leonard E. Forsythe Sur. 41, 3 mi. SW Sidney, TD 2,688 ft., PB 2,176 ft., elev. 1,482 ft., Marble Falls 2,088 ft., gas pay 2,090 ft., 5,210,000 cu. ft. gas daily, open 2-in. tubing, SIP 890 psi.

Stephens County: Oil Associates, Inc. 1 Black "A" lease, 23-4-SPRR, 7 mi. NE Breckenridge, TD 4,257 ft., elev. 1,308 ft., Caddo 3,361 ft., pay 4,065 ft., 20,500,000 cu. ft. gas daily, open flow, SIP 1,685 ft.

Stonewall County: Deep Rock Oil Corp. 1 C. B. Long, NE NE Sec. 2, GH&H Sur., A-1765, NE corner of county, TD 5,134 ft., elev. 1,608 ft., Strawn sand 5,129 ft., flowed 106.5 bbl. of 37°-gravity oil a day from open hole at 5,124-34 ft., ¾-in. choke, GOR 300 cu. ft., CP 37 psi., TP 20 psi.

NORTH TEXAS (DISTRICTS 9 AND 7-B) WILDCAT FAILURES

Brown County: C. W. Phayer 1 Ross, Sec. 6, ETRR Sur., 4 mi. SE May, dry, TD 2,850 ft., elev. 787 ft., Ellenburger 2,803 ft.

Callahan County: Connally-Thornton 1 W. J. Cross, Blk. 855, Maxwell Steel Sur., 1 mi. S Cottonwood, dry, TD 4,008 ft., elev. 1,785 ft., Caddo 2,835 ft., Ellenburger 3,887 ft.

Taxman Oil Co. et al 1 R. L. McKinney, Sec. 2,284, TE&L Sur., 2½ mi. NE Putnam, dry, TD 3,350 ft., Caddo 3,211 ft.

Clay County: L. T. Burns 1 H. P. Williams, Sec. 3,222, TE&L Sur., A-583, 3 mi. SW Buffalo Springs, dry, TD 4,497 ft.

C. B. Christie, Jr. 1 H. D. and R. Stine, Blk. 58, Bacon Subd., 2 mi. SW Petrolia, dry, TD 1,914 ft.

W. H. Mitzner 1 C. J. Shumake, Blk. 5, Bacon Subd., 2 mi. E Thornberry, dry, TD 1,951 ft.

Shaw Oil Co. 1 J. P. Boddy, Blk. 51, Bacon Subd., 5½ mi. W Petrolia, dry, TD 2,895 ft. in Cambrian.

Cooke County: A. D. McDuffie 1 W. S. Barcus, C. F. Stanley Sur., Blk. A-904, 4 mi. W Marysville, dry, TD 1,376 ft.

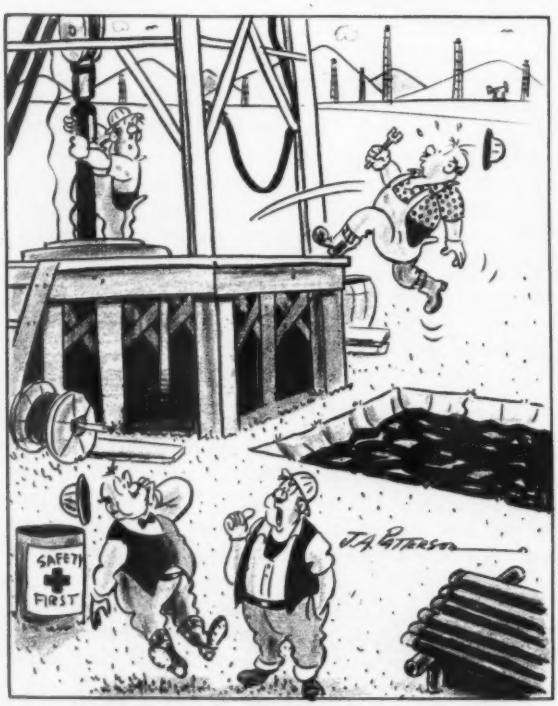
A. D. McDuffie 2 W. S. Barcus, C. F. Stanley Sur., A-904, 4 mi. W Marysville, dry, TD 1,504 ft.

Eastland County: L. W. Roche 1 F. W. Taylor, Lot 11, Thomas A. Howell Sur., A-152, 5½ mi. SE Ranger, dry, TD 3,791 ft., elev. 1,483 ft., Caddo 3,135 ft., Barnett 3,655 ft., Ellenburger 3,750 ft.

Jack County: Paul Bilbrey and Wayne Albritton 2 Singleton, M. Rockerfellow Sur., A-484, 2 mi. NW Antelope, dry, TD 763 ft.

Jones County: Three Brothers Oil Co. 1 S. E. Lawrence, Sec. 24, D&DAL Sur., 1 mi. W Avoca, dry, TD 3,381 ft., elev. 1,550 ft., reef 3,371 ft.

Nolan County: Cities Service Oil Co. 1 Cooper, NW NW 41-23-T&P, 2 mi. NW Roscoe, dry, TD 7,360 ft., elev. 2,385 ft., San Angelo 1,000 ft., Clear Fork 1,636



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ft., Elm Creek 2,080 ft., Wichita Albany 2,430 ft., Caddo 6,960 ft., Mississippian 7,012 ft., Ellenburger 7,077 ft.

Parker County: Akin & Dimock 1 Lloyd Doughty, B. F. Hemphill Sur., A-705, 9 mi. N Weatherford, dry, TD 3,467 ft., elev. 1,057 ft., Caddo 3,150 ft.

Shackelford County: C. E. Groover 1 Walker-Buckler Trust, 60-13-T&P, dry, TD 1,960 ft.

Stonewall County: C. E. Prince 1 L. M. Fisher, NE SW 210-D-H&TC, 2 mi. N Swenson, dry, TD 6,512 ft., elev. 1,863 ft., Dotham 3,130 ft., Home Creek 5,040 ft., Caddo 6,252 ft., Mississippian 6,370 ft.

Taylor County: I. C. Little and Roy L. Crawford 1 A. P. Head, Sec. 459, Subd. 13, G. W. Baldwin Sur., 1½ mi. E Bradshaw, dry, TD 4,840 ft., elev. 1,935 ft., Caddo 4,560 ft., Ellenburger 4,799 ft.

Southern Petroleum Exploration, Inc. 1 Mrs. Roma Manly, 20-4-BAL, 4 mi. NE Abilene, dry, TD 4,460 ft., Palo Pinto 3,232 ft., Strawn sand 3,919 ft., Caddo 4,390 ft.

Young County: G. F. LeBus, Jr. and Roy H. LeBus 1 J. O. Stratton, Susan Sallie Sur., A-252, 3 mi. N Loving, dry, TD 3,601 ft.

Oltex Drilling Co. 2 Wm. Thomas, Blk. 2,447, TE&L Sur., 6 mi. W Olney, dry, TD 1,280 ft., Gunsight lime 1,254 ft.

Rankin, Pitcock, and Mid-Continent Petroleum Corp. 1 Mrs. Irene McPherson, I. L. Aud Sur., A-1, 3 mi. NW Graham, dry, TD 4,718 ft., elev. 1,083 ft., Caddo 3,834 ft., Barnett 4,610 ft., Mississippian 4,648 ft.

Mississippi

Alabama Wildcat Cores Impure Salt Stringer

JACKSON. — On the Hatchetigbee Anticline, Clarke County, Alabama, Danciger Oil & Refining Co. 1 John F. York, NE SE 1-7n-1w, encountered the first impure salt stringer in cores at 12,020-70 ft. Coring in this wildcat has been continuous to the present depth of 12,319 ft., with recovery being interbedded shale, limestone, anhydrite, and thin beds of impure salt. Electric log was run to 12,317 ft. and operators are changing to salt-saturated mud before coring ahead. It is reported that an effort will be made to carry this test beyond contract depth of 12,500 ft. if neither solid salt nor a permeable section are encountered.

In Kingston field, Adams County, Mississippi, Stanolind Oil & Gas Co. is running production casing prior to testing 1 G. W. Armstrong, 11-5n-2w, west offset to the field discovery. Plains Production Co. 1 W. C. Walker, 11-5n-2w. The 1 Armstrong was drilled to a depth of 6,791 ft. and electric log was run and sidewall samples were taken. Shows were recovered at 6,488-93 ft., 6,583-85 ft., and 6,644-47 ft. in the Wilcox. If this test is successful, it will be the second producer for the field. Two dry holes have been drilled in the area since the discovery was completed.

Kemp Drilling Co. and Petersen Drilling Co. have abandoned their 1 Annie Minter, 20-5n-1w, Adams County wildcat, at total depth of 7,008 ft. Four sidewall cores recovered sand with shows of oil with the best show considered at 6,632 ft. However, operators believed these were noncommercial. Other shows were cored at 6,697 ft., 6,698 ft., 6,699 ft., and 6,700 ft.

Rig is being moved in to drill a 5,000-ft. wildcat in eastern Neshoba County, and operations are expected to get under way in the near future. The test is Harry W. Elliott et al 1 Mrs. Laura May Cook Eakes, C NW SE SE 36-11n-13e.

Lion Oil Co. 1 M. E. Allred, C NW SW 23-6n-6e, Lincoln County, confirmation test to West Lincoln field, was completed for 53 bbl. of 40°-gravity oil daily on pump. Production is through perforations in the

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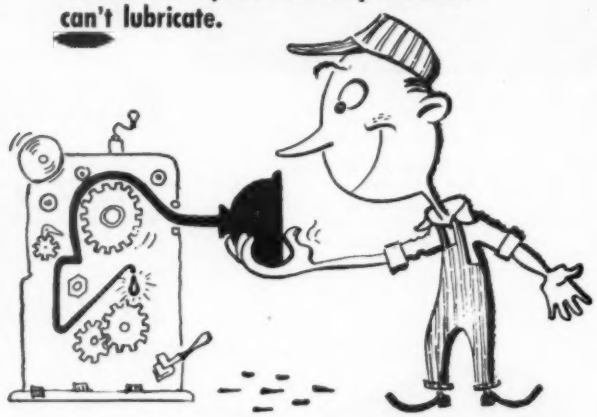

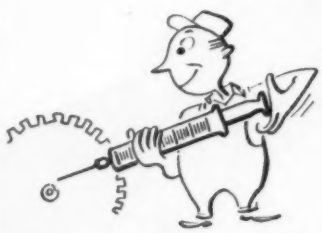

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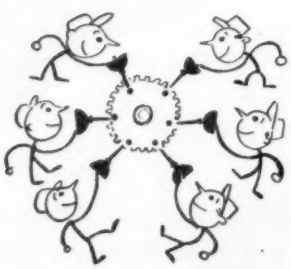

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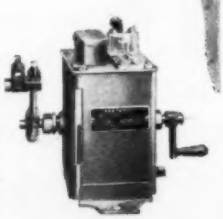

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lower Tuscaloosa at 10,659½-60½ ft. This is a south offset to the discovery well.

ALABAMA WILDCAT FAILURE
Baldwin County: John S. Neilson and W. E. Walker 1 C. H. Bryars, 36-2n-2e, dry, TD 6,126 ft.

FLORIDA WILDCAT FAILURE
Suwannee County: Field & Randall 1 G. D. Crawley, 6-2s-13e, dry, TD 3,833 ft.

MISSISSIPPI WILDCAT FAILURE
Madison County: Gulf Refining Co. 1 J. R. Anderson, 2-8n-1w, dry, TD 10,211 ft.

Permian Basin

Amerada Has Second Prospect in Terry County

MIDLAND. — Amerada Petroleum Corp. has a second prospective Wolfcamp, lower Permian, well in southern Terry County, at its 2 Willard, NW NW 6-C37-PSL, one location west of the same firm's 1 Willard.

The 2 Willard ran a drill-stem test in the Wolfcamp at 8,457-8,520 ft. Gas showed in 8 minutes, oil in 2½ hours, which gaged 19.29 bbl. the first hour and 4.67 bbl. the next half hour. There was no formation water and drill pipe unloaded while coming out. Recovery on the 4-hour test was 4,987 ft. of oil and 619 ft. of oil and gas-cut mud. Flowing pressure climbed from zero to 2,010 psi., and 45-minute shut-in pressure registered 3,370 psi. Gas-oil ratio was 474 cu. ft. and gravity was 41.9°. Operators cored ahead to 8,550 ft. and were running electrial survey.

Amerada 1 Willard, NE NW 6-C37-PSL, was drilling ahead below 11,984 ft. in lime and chert.

Location had been staked for Amerada's 3 Willard in the SE NW of Section 6, which makes it a south offset to the 1 Willard. Projected depth of the new test was 9,000 ft.

Amerada staked location for its 6 J. H. Hicks as a 9,000-ft. test in the center of the Adair San Andres field of northeast Gaines County. It will be watched with interest as the location, 896 ft. from north and 8,600 ft. from east lines of 19-C31-PSL Survey, is about 2 miles southeast of the 1 Willard in Terry County.

In southeastern Lynn County, Houston Oil Co. 1 H. B. Howell, near NE NE 451-1-ELRR, prospective Strawn sand discovery, was filling the hole at the rate of ½ bbl. of oil an hour, following a 2,000-gal. acid treatment. Total depth was 9,360 ft. in lime.

Magnolia Petroleum Co. 1 W. W. Caswell, 431-9-ELRR, west offset to their 1 Garza Land & Cattle Co., O'Donnell field reef discovery, recovered shale and lime from 9,054-66 ft., dense lime and shale from 9,069-74 ft., and 15 ft. of dense lime with slight fractures and no shows, from 9,074-89 ft. A drill-stem test was under way to 9,089 ft. at last report.

Humble Oil & Refining Co. 1 W. C. Dulin, Section 431, northwest offset to the O'Donnell discovery, cored 25 ft. of dense lime from 9,954-79 ft., and was pulling core barrel from total depth of 9,214 ft.

In the southwest corner of Ector County, Amerada 1 Carlinville National Bank, step-out Ellenburger wildcat in 18-46-Gunter & Munson Survey, had flowing oil on a drill-stem test in the Waddell sand of the Simpson.

The drill-stem test was from 10,070-10,170 ft., and was open 10 hours and 15 minutes, using 1,100 ft. of water blanket. Gas showed in 2 hours and water blanket in 2 hours and 45 minutes. Oil showed in 3 hours and 15 minutes. The flow was turned into tanks immediately which gaged 170.75 bbl. of 42.2°-gravity oil in 6 hours.

Location of the new well is 2,635 ft. from east and 3,270 ft. from south lines of Section 18, which is approximately 3 miles from west and ½ north of south county lines. It is 4,000 ft. south of nearest Ellen-

burger production in the Yarbrough & Allen field, and was reported to be about 72 ft. high, on the Waddell section, to the Yarbrough & Allen discovery, 3 miles north and slightly west.

WEST TEXAS (DISTRICTS 8 AND 7-C) SUCCESSFUL WILDCATS

Crane County: Union Sulphur Co., Inc. 1 R. B. Robbins, 660 ft. from NE and SE lines 27-35-H&TC, 6 mi. NW McCamey, TD 5,503 ft., PB 3,419 ft., elev. 2,347 ft., upper Clear Fork pay 3,407-19 ft., 55 bbl. 40.6°-gravity oil a day, ¼ in. choke, GOR 1,820 cu. ft., TP 185 psi., suggested name "Robbins."

Terry County: Union Oil Co. of California 1 Laura A. Cotten, SE NE 91-T-D&W, 4 mi. SE Brownfield, TD 10,182 ft., PB 10,150 ft., elev. 3,262 ft., Pennsylvanian 9,902 ft., pay 9,30 ft., perf. 9,998-10,073 ft., flowed natural 1,812 bbl. 44°-gravity oil a day through 1⅝-in. opening on 2-in. tubing. GOR 746 cu. ft., TP 400 psi.

WEST TEXAS (DISTRICTS 8 AND 7-C) WILDCAT FAILURES

Andrews County: Anderson Prichard Oil Corp. 1 Fasken H-15, NE SW 15-41-T2N-G&MMB&A, 4½ mi. E Midland Farms field, dry, TD 4,900 ft., elev. 2,990 ft., anhydrite 1,920 ft., Yates 3,041 ft., Grayburg 3,550 ft.

Borden County: L. H. Armer and Leonard 1 L. D. Rodgers, NW SE 29-31-T3N-T&P, 4 mi. E Vealmoor field, dry, TD 8,025 ft., elev. 2,475 ft., reef 7,950 ft.

Crockett County: Anderson & Starr 1 Stanolind-University, 22-42-University Lands, 5 mi. E Midway Lane field, dry, TD 1,555 ft.

C. P. Laubenheim 1 F. D. Henderson, 18-ST-GC&SF, 9 mi. NW Ozona, dry, TD 1,603 ft.

Magnolia Petroleum Co. 2 Clayton Ranch, NE NE 12-GH-GC&SF, ¾ mi. NE 1 Clayton, Ellenburger gas-distillate discovery; dry, TD 9,008 ft., elev. 2,488 ft., Pennsylvanian 8,518 ft., Fusselman 8,628 ft., Montoya 8,718 ft., Ellenburger 8,835 ft.

Byron Williams 1 Ruby Helbing, 17-QR-TCRR, 9 mi. SW Ozona, dry, TD 1,725 ft.

Garza County: Seaboard Oil Co. of Delaware 1 Swenson est., SW NW 34-2-H&GN, 5 mi. NW Weiner 1 Garza, NE corner of county; dry, TD 7,812 ft., elev. 2,377 ft., Clear Fork 2,755 ft., Pennsylvanian 7,195 ft., Mississippian 7,778 ft.

Irion County: J. B. Ewing 1 W. M. Noelke, NW NW NE 5-A635-TCRR, 10½ mi. SW Mertzon, dry, TD 1,470 ft., elev. 2,596 ft., bailed 3 bbl. oil in 5½ hr. from 1,410-14 ft.

Honolulu Oil Corp. and Devonian Oil Co. 1 D. D. Wall, 5-5-H&TC, 4½ mi. SE Funk field, dry, TD 1,490 ft.

Kent County: Big Chief Drilling Co. 1 Big Chief, Constantin & Glasco, SE NW 11-B-Unit B-PSL, 18 mi. W Girard, dry, TD 7,713 ft., elev. 2,412 ft., San Andres 1,540 ft., Glorietta 2,460 ft., Clear Fork 2,640 ft., Wolfcamp 4,620 ft., Mississippian 7,675 ft.

Kimble County: Anzac Oil Corp. 1 Lottie Bolt, Sec. 58, C. W. Roberts Sur. A-1442, 1½ mi. SE Bolt field, dry, TD 1,850 ft., elev. 1,750 ft., Strawn 1,250 ft., Ellenburger 1,800 ft.

Loving County: I. A. Stephens 1 Ollie P. Anderson, Sec. 28-29-PSL, 8 mi. E Wheat field, dry, TD 5,186 ft., elev. 2,928 ft., Delaware lime 5,015 ft., sand 5,033 ft.

Runnels County: Bouchard & Callihan 1 Tinkle, H&TC Sur., 333, 1 mi. E Winters field, dry, TD 4,627 ft., elev. 1,822 ft., Ellenburger 4,586 ft.

Scurry County: Standard Fryer Drilling Co. 1 Jessie Koonsman, 157-2-H&TC, 12 mi. NE Kelly-Snyder field, dry, TD 7,405 ft., elev. 2,155 ft., Ellenburger 7,200 ft.

Sutton County: Gem Oil Co. 1 Vanderstucken, SE SE 60-14-TW&NG, 16 mi. SE Sonora, dry, TD 5,911 ft.

Tom Green County: C. S. Starr 1 L. T. Clark, 85-5-H&TC, 4 mi. W Water Valley, dry, TD 1,287 ft., elev. 2,273 ft., San Andres 945 ft., sand 1,280 ft.

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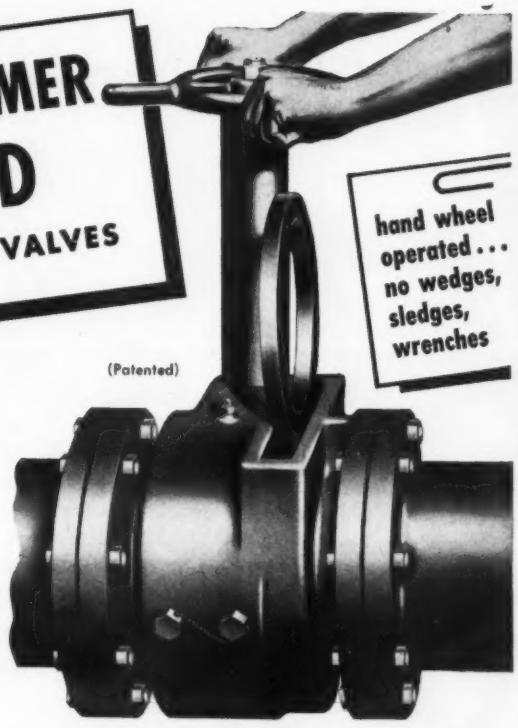

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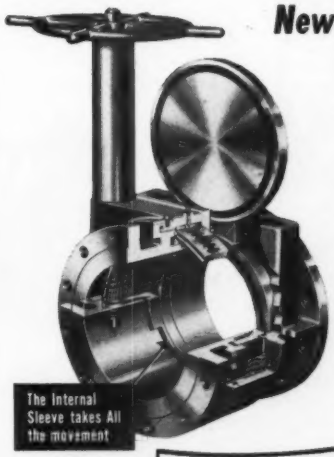

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post to Saunders field, set 5½-in. casing at 10,040 ft., total depth, then drilled out to 10,020 ft. Perforations from 9,976-95 ft., in the Pennsylvanian, flowed 152 bbl. of oil and 62 bbl. of salt water in 8 hours, following a 500-gal. acid treatment. Following that test it flowed 193 bbl. of oil and 171 bbl. of water in 15 hours and died. Operators then swabbed 98 per cent salt water. Top of the Pennsylvanian was 9,520 ft., on elevation of 4,194 ft.

Two miles north of production in Denton field, Ralph Lowe 1 Dickinson, SE SW 35-14s-37e, had total depth at 9,412 ft. and had stopped to run electrical surveys. A drill-stem test in the Wolfcamp at 9,169-9,248 ft., open 2 hours, had gas in 30 minutes and recovered 7,850 ft. of oil, 100 ft. of oil and gas-cut mud and 850 ft. of oil and gas-cut sulfur water. Flowing pressure was 2,795 psi.

Three other drill-stem tests were: From 9,227-48 ft., open 55 minutes, recovery was 250 ft. of slightly gas-cut mud; at 9,226-9,300 ft., open 2 hours, recovery was 120 ft. of oil and gas-cut mud, on flowing pressure of 200 psi.; and from 9,299-9,412 ft., open 1 hour and 20 minutes, recovery was 95 ft. of drilling mud with no shows.

Gulf Oil Corp. 1 Sams-State, 17-15s-33e, southwest of Saunders field, was drilling limestone and chert at 13,438 ft. On elevation of 4,221 ft., top of the Mississippian was placed at 13,282 ft.

Eastern Texas

Area Activity Marked By New Wildcat Locations

DALLAS.—East Texas areas received a number of new wildcat locations this week. Included were: In Hopkins County, B. F. Phillips, Dallas, had location staked for his 1 Blackwell-Rogers for a Paluxy test, located 467 ft. from east and 660 ft. from south lines of the John Nideaver Survey, A-707, 2 miles northwest of the Peerless townsite. It was to be drilled to around 4,500 ft., and at last report, drilling contract had not been let.

Goss Drilling Co., Honey Grove, Tex., made application to drill 1 Stephen Rumore, as a 3,200-ft. wildcat 3 miles southeast of Detroit, in Hopkins County. Location is 330 ft. from south and west lines of a 10-acre tract in the Edward Dean Survey.

In Titus County, Dr. James M. Kerr and E. X. Birdsong, Longview, staked location for a 4,300-ft. wildcat 6 miles southwest of Mount Pleasant. It is to be the 1 E. X. Birdsong, located 5,074 ft. from north and 592 ft. from east lines of a 265-acre lease in the Joseph Meacham Survey.

Wood County received a deep test at Hassie Hunt Trust 1 H. O. Hoard, 6½ miles east of Mineola on a 700-acre lease in the James Brewer Survey. The wildcat was scheduled to 10,500 ft. with company tools.

Roger B. Owings was reported ready to start a Woodbine wildcat, about 6½ miles northeast of Tyler in Smith County. Application had not been filed, but according to reports, location was 330 ft. north of the south line and 2,000 ft. west of the east line of the John W. Warren Survey, A-1,029, on the Adella Lolley 340-acre tract. The location would be 1½ miles northwest of production in Chapel Hill field where production is from the Pettit limestone around 8,075 ft.

EAST TEXAS (DISTRICTS 5, 6 AND 6-P) SUCCESSFUL WILDCATS

Anderson County: E. L. Howard and Cooper-Herring 1 Odell Clewis, A. Hendley Sur., 10 mi. E Slocum, TD 5,290 ft., elev. 291 ft., flowed 129.25 bbl. 42°-gravity oil a day, 12/64-in. choke, Blossom sand open hole 5,285-90 ft., TP 320 psi., GOR 760 cu. ft.

Falls County: C. E. Litteral 1 Cavitt est., J. M. Graham Sur., 3 mi. NE Lott, TD

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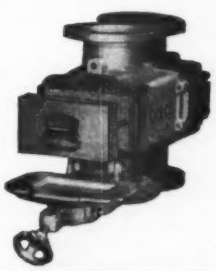

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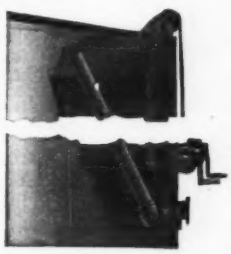

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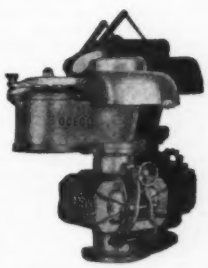

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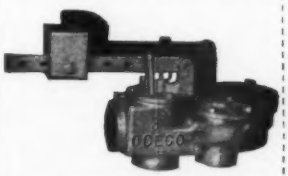

V-109 STILL TYPE VALVES combine vacuum and pressure relief in a single valve. 3", 4" and 6" sizes. Pressure settings from 2 to 25 lbs. per sq. inch. Vacuum settings from 1 oz. to 10 oz. Temperatures up to 600° F.

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1,121 ft., flowed 120.8 bbl. 32°-gravity oil a day, open hole 1,112-21 ft.

Kaufman County: T. D. Humphrey 2 N. E. Tharp, D. Cervantes Sur., A-79, 30 ft. E 1 Tharp, TD 6,760 ft., elev. 378 ft., perf. Bacon limestone 6,118-66 ft., flowed 170 bbl. 40°-gravity oil a day, 16/64-in. choke, GOR 267 cu. ft., TP 100 psi.

EAST TEXAS (DISTRICTS 5, 6 AND 6-P) WILDCAT FAILURES

Bosque County: American Liberty Oil Co. 1 Smith, Israel Patchins Heirs Sur., 2 mi. N Walnut Springs, dry, TD 5,855 ft., elev. 1,112 ft., Barnett 5,335 ft., Ellenburger 5,521 ft.

Hopkins County: Louis E. Ardis 1 J. L. and J. D. McMullen, W. H. Barker Sur., A-96, 3 mi. W Sulphur Springs, dry, TD 6,002 ft., base Austin 3,610 ft., sub-Clarksville 3,654 ft., Paluxy 5,905 ft. by samples.

Oklahoma

Stephens County Wildcat Completed as Producer

PEPPERS REFINING CO. has confirmed field reports that it has opened what appears to be a promising new pool in the area about 5 miles northwest of Marlow in northwestern Stephens County. The discovery well, 1 Smith, NW SW SE 4-2n-8w, flowed 20 bbl. of clean oil per hour for the first 4 hours through chokes of various sizes. Restricted to a 20/64-in. choke the next 13 hours, the flow was at the rate of 8 bbl. per hour. Production is from Hoxbar sand, opposite which casing was perforated at 6,705-38 ft. Total depth is 7,198 ft. with casing cemented at 7,020 ft. Nearest other production is in the West Marlow pool, 4 miles to the south.

Production of the active southeastern extension area of the Velma pool in southeastern Stephens County has been extended another half mile further southeastward with the completion by Sinclair Oil & Gas Co. of its 1 Arnett, NW SE NE 3-2s-4w. The well flowed 283 bbl. of oil in a 13-hour run with gas at the rate of 468,000 cu. ft. per day. Production is from the Velma sand, topped at 5,893 ft. Hole was drilled to a total depth of 6,330 ft. Casing is at 5,896 ft.

In Payne County, H. Waggoner & Co. has proved either a new pool or an important extension for the West Markham pool. The discovery well is 1 Matlin, SW SW NE 7-18n-6e. In Red Fork sand at 3,094-3,115 ft. it flowed initially at the rate of 10 bbl. of oil per hour and then, pinched to 11/64-in. choke, made 4½ bbl. per hour. Gravity is 38° A.P.I. The area is about 5½ miles northeast of Cushing, and west of the West Markham pool.

A new producing area also has been opened in Lincoln County. It is located west of the Laffoon pool, about 10 miles southwest of Stroud where Hubbell & Webb 1 Powell, NE NE SE 5-13n-6e, flowed at the rate of 56 bbl. of 42°-gravity oil and 15,000,000 cu. ft. of gas per day on a completion test through 11/32-in. choke. Total depth is 3,132 ft. with hole open below 3,084 ft.

Sinclair Oil & Gas Co. has run casing to test oil and gas showings encountered in its 1 Threatt, NE NE SW 18-14n-2e, 3 miles west of Wellston, also in Lincoln County. Latest showings were in the Hunton lime. Approximately 2,250 ft. of gas-cut mud was recovered in a drill-stem test at 5,162-5,203 ft. Small showings previously had been found in the Red Fork, Skinner and Oswego zones. The zone last tested is at the bottom of the hole. Casing seat is at 5,158 ft. The location is about a mile northwest of the Sunflower pool, opened last May by Coronado Oil Co. The discovery, and so far only well in that pool, produces from the lower Skinner sand at 4,872-82 ft.

OKLAHOMA SUCCESSFUL WILDCATS

Kiowa County: J. W. Creel & Sons 1 Stamatie, NW NW NW 34-7n-16w, Gotebo district, elev. 1,433 ft. DF, pumped 6 bbl. of 40°-gravity oil per day from sand at 444-51 ft., TD 460 ft.

Lincoln County: Hubbell & Webb 1 Powell, NE NE SE 5-13n-6e, ⅞ mi. NW Laffoon, elev. 819 ft., flowed 55 bbl. of 42°-gravity oil per day from Prue at 3,082-3,133 ft., TD; Hogshooter 1,825 ft., Checkerboard 2,225 ft., Oswego 3,042 ft., Oswego lime 3,053 ft., Prue 3,082 ft.

Major County: Mazda Oil Corp. 1 Scannell, NE NE NE 3-21n-11w, 2 mi. W Ringwood, elev. 1,286 ft,, flowed 80 bbl. oil per day from Manning at 6,918-81 ft., TD 7,400 ft., tight hole.

Noble County: T. N. Berry 2 Frederick, SE SE NE 33-20n-2w, elev. 1,123 ft., flowed 3,721,000 cu. ft. of gas per day from second Tonkawa at 3,102-14 ft., TD 3,670 ft., Oread 2,910 ft., first Tonkawa 2,980 ft., Avant 3,477 ft., Perry 3,638 ft.

Oklahoma County: Peppers Refining 1 Fink, NW NW NW 15-13n-3w, 1⅜ mi. E Britton, elev. 1,181 ft., 25 bbl. oil per day from Bartlesville at 6,360-80 ft., TD 7,016 ft., conglomerate 5,813 ft., Hogshooter 5,400 ft., Checkerboard 5,620 ft., Oswego 6,111 ft., Sylvan 6,610 ft., Viola 6,711 ft., dolomite 6,822 ft., second Wilcox 6,999 ft.

Pontotoc County: Sam Yingling 1 Walker, SE SE NE 20-5n-5e, NE Bebee area, elv. 975 ft. DF, pumped 25 bbl. 36°gravity oil per day from Viola and Hunton at 2,387-2,629 ft., TD 2,901 ft., Calvin 1,792 ft., Woodford 1,986 ft.

OKLAHOMA WILDCAT FAILURES

Carter County: G. O. Parker 1 Ward, SW SE SW 26-4s-1w, elev. 924 ft. DF, geological test below 4,981 ft., dry, TD 6,407 ft., Lone Grove 5,172 ft., all sands had salt water.

Garvin County: Fleet Drilling 1 Blanto, SE SE SW 5-3n-2e, dry, TD 3,429 ft., Hogshooter 2,718 ft., McKinney 2,906 ft., Burns sand 2,964 ft., basal Pennsylvanian bromide 3,068 ft., first bromide sand 3,147 ft., basal bromide sand 3,241 ft., McLish 3,360 ft.

L. A. Edwards, Jr. 1 Keltner, NE SE NW 30-1n-3w, elev. 1,029 ft., dry, TD 6,600 ft., Canyon 3,610 ft., upper Dornick Hills 4,700 ft., Springer 4,910 ft., limy sand 5,940 ft. and 6,024 ft., shale 6,043 ft.

Greer County: Harvey Drilling 1 Baar, SE SE NE 2-3n-23w, dry, TD 5,305 ft., Pontotoc 2,176 ft., Cisco 2,936 ft., Canyon 3,700 ft., Strawn 4,047 ft., Arbuckle 4,778 ft.

Jefferson County: W. J. Mosley et al 1 Aulman, SE SE SE 12-5s-8w, dry, TD 3,401 ft., sandy shale 3,125 ft., Canyon 3,339 ft., Arbuckle 3,373 ft.

Perry Browning 1 King et al, SW NE NW 17-5s-8w, dry, TD 2,094 ft., sand 1,639 ft., 1,894 ft., and 2,054 ft., no shows.

Lincoln County: Woods Drilling 1 Seaba, SW SW NE 19-17n-4e, elev. 949 ft., dry, TD 3,958 ft., Layton 2,845 ft., Checkerboard 3,080 ft., Big lime 3,565 ft., Oswego 3,602 ft., Skinner 3,739 ft., lime 3,885 ft., Red Fork 3,928 ft.

Love County: Mid-Continent Petroleum Corp. 1 Sullivan, NW NW NW 6-6s-1w, elev. 889 ft. DF, dry, TD 7,128 ft., Zuckerman lime 2,710 ft., upper Daube lime 3,080 ft., Daube lime 3,135 ft., Bayou lime 3,970 ft., Lone Grove 4,030 ft., first upper Bayou sand 4,480 ft., second upper Bayou sand 4,700 ft., first Bayou sand 4,920 ft., Chubbee (?) 5,100 ft., Lone Grove 5,750 ft., shale 6,303 ft., sand 6,718 ft.

Murray County: W. L. Wolfe 1 Wolfe, NW NE NW 31-1n-3e, dry, TD 1,407 ft., shale and lime 108 ft., lime 118 ft., sandy shale 210 ft. shale and shaly sand 252 ft., sand 442 ft., limy shale 790 ft., sand 845 ft. and 892 ft.

Okfuskee County: Falcon-Seaboard 1 Replogle, NW SE SE 13-13n-8e, elev. 824 ft., dry, TD 4,141 ft., Checkerboard 1,112 ft., conglomerate 1,171 ft., Big lime 2,104 ft., Oswego 2,156 ft., Prue 2,173 ft., coal 2,300 ft., Earlsboro 2,680 ft., Inola 2,866 ft., lower Bartlesville 3,029 ft., lime 3,069 ft., Booch 3,206 ft., Union Valley 3,434 ft., Pitkin 3,461 ft., Mayes 3,700 ft., Woodford 3,925 ft., Hunton 3,942 ft., Sylvan 3,967 ft., Viola 4,052 ft., Wilcox 4,090 ft., second Wilcox 4,110 ft.

Smith & Cleary, Inc. 1 Hayes, NE NW SE 25-13n-8e, elev. 820 ft., dry, TD 4,036 ft., lime 3,145 ft., Booch 3,240 ft., Gilcrease 3,380 ft., sand 3,400 ft., Union Valley 3,470 ft., Cromwell 3,475 ft., Pitkin 3,515 ft., Woodford 3,995 ft., Hunton 4,023 ft.

Robinson Oil and Viersen & Cochran 1 Swaltney, SW NW SW 11-12n-9e, elev. 863 ft., dry, TD 4,034 ft., Gilcrease 3,205 ft., Union Valley 3,290 ft., Pitkin 3,305 ft., Mayes 3,625 ft., Hunton 3,792 ft., Sylvan 3,850 ft., Viola 3,928 ft., dolomite 3,973 ft., Wilcox 3,990 ft.

Oklahoma County: Mitchell-Gage Drilling 1 Laughlin, NE NE SW 12-12n-1e, elev. 1,106 ft., dry, TD 6,023 ft., Mayes 5,492 ft., Woodford 5,528 ft., Misener 5,575 ft., Hunton 5,603 ft., Sylvan 5,668 ft., Viola 5,768 ft., dense 5,815 ft., sandy dolomite 5,834 ft., Wilcox 5,900 ft., second Wilcox 5,999 ft.

Pottawatomie County: E. C. Clay & Son, Inc. 1 Good, SE SE NW 3-11n-5e, elev. 991 ft., dry, TD 4,861 ft., Hogshooter 2,240 ft., Checkerboard 2,570 ft., Oswego 3,395 ft., Prue 3,410 ft., upper Skinner 3,537 ft., Inola 4,000 ft., lime 4,110 ft., Mayes 4,390 ft., Woodford 4,550 ft., Hunton 4,600 ft., Sylvan 4,680 ft., Viola 4,775 ft., dense 4,810 ft., dolomite 4,830 ft., Wilcox 3,856 ft.

Seminole County: J. S. Wise 1 Carr, NW NE NW 36-11n-5e, elev. 944 ft., dry, TD 4,754 ft., Belle City 1,610 ft., Hogshooter 2,005 ft., lower Hogshooter 2,070 ft., Checkerboard 2,385 ft., Big lime 2,788 ft., Oswego-Prue 3,145 ft., Verdigris 3,385 ft., Skinner 3,435 ft., Earlsboro 3,666 ft., Inola 3,820 ft., Bartlesville 3,840 ft., lime 3,935 ft., Mayes 4,282 ft., Woodford 4,395 ft., Misener 4,439 ft., Hunton 4,445 ft.

P. A. Doheny 1 Alec, SE SW NE 26-10n-7e, elev. 1,050 ft., dry, TD 4,513 ft., sand 1,775 ft., Booch 3,449 ft., Gilcrease 3,563 ft., Cromwell 3,646 ft., Misener 4,240 ft., Hunton 4,259 ft., Sylvan 4,352 ft., Viola 4,445 ft., Wilcox 4,509 ft.

W. A. Delaney, Jr. 1 Holatka, SE SE SW 24-7n-7e, elev. 959 ft., dry, TD 3,696 ft., lower Wewoka sand 1,360 ft., Calvin 1,518 ft., third Calvin 1,660 ft., gasal Calvin 1,745 ft., coal 1,926 ft., Earlsboro 2,552 ft., lime 3,232 ft., Gilcrease 3,403 ft.

Ohio Fields

Good Gas Pay Found In Perry County

COLUMBUS.—Mid East Oil found a good gas pay in the top of the sand in the 2 Elmo Cotterman, Section 28, Hopewell Township, Perry County. The Clinton was topped at 2,991 ft. and drilled to 2,999 ft. where the open flow was 2,300,000 cu. ft. of gas.

In Harrison Township, Perry County, the Foraker Drilling 1 Lewis & White, Section 33, logged the Clinton at 2,733-78 ft. with 200,000 cu. ft. and a nice showing of oil.

Preston Oil moved out nearly a half mile to the northeast from the 1 Daliere and brought in a nice well on James Allen, Section 18, New Castle Township, Coshocton County. Clinton sand was found at 3,341 ft. and produced 85 bbl. in 24 hours after shot.

Fickel & Goss completed a wildcat on the E. M. Brown tract in Section 1, Falls Township, Hocking County, and just north of Logan, as a small producer. Clinton sand at 2,640-67 ft. had a small oil showing and made 28 bbl. in 24 hours after a 90-qt. shot.

Kansas

Skelly Opens Its Second Forest City Basin Pool

SKELLY OIL CO. is opening its second new Forest City Basin pool. Its 1 Fearon, NW SW NE 1-11-11e, northern Wabaunsee County. swabbed at the rate of 12 bbl. of clean oil per hour. Pay zone is Viola lime, topped at 2,901 ft. (—1,773 ft.), and drilled to 2,904 ft. Oil rose 1,750 ft. in the hole when plug was drilled. This wildcat is 12 miles northeast of the same company's 2 Thoewe, SW SE NE 2-13n-10e, which is opening a new pool in the south central part of the county. There, pumping equipment is being set up for completion of the well. In one 70-minute test, it swabbed 75 bbl. of clean oil. Its pay zone also is the Viola lime, topped at 2,923 ft. (—1,816 ft.), and drilled to 2,927 ft.

G. D. Smitherman and associates are completing their 1 Foley, SW SW NW 15-28-5, opening a new producing spot at the south edge of the Landsdown townsite, eastern Kingman County. The location is just a mile northeast of another wildcat producer recently completed by Earl Wakefield at 1 Broadway, SE SE NW 21-28-5. Both wells produce from the Mississippian dolomite, topped at 3,818 ft. (—2,416 ft.) in the Smitherman well, and 3,815 ft. (—2,431 ft.) in the other. In the latter well, casing was run through the section and perforated at 3,832-36 ft. In the former, hole is open below 3,800 ft., taking in the upper part of the Mississippian, topped at 3,797 ft. Total depth is 3,822 ft., in the dolomite. In this well, production is estimated good for 100 bbl. of oil daily. The Wakefield well made about 50 bbl. per day with considerable water at first.

The area already has another prospective producer at Westgate-Greenland Oil Co. 1 Beck, NE NE NE 29-28-5, a half-mile southwest of the Wakefield discovery well (Broadway pool), where casing has been run to test oil showing in the Mississippian, topped at 3,837 ft. (—2,420 ft.) and the dolomite, cut at 3,873 ft. (—2,456 ft.). Total depth is 3,882 ft.

The Landsdown area is about 5 miles southwest of the expanding Bartholomew pool, nearest other production. Main pay zone of that pool also is the Mississippian dolomite.

Continental Oil Co. 1 Cavin, SW SW NW 29-33-11, southeastern Barber County, in the extreme southern part of the state, swabbed at an average rate of nearly 2 bbl. per hour while testing oil showings in the Mississippian. The formation was topped at 4,494 ft. (—3,076 ft.). Bottom of the hole is 4,585 ft. with 7-in. casing at 4,570 ft. The well, located 2½ miles southwest of the Rhodes pool, was started as a stratigraphic test.

First Lansing-Kansas City lime production for the Saundra pool, northern Stafford County, has been established with the completion by Virginia Drilling Co. of its 3 Taylor, SW NE NE 22-21-12. The well tested water with only a small show of oil in the Arbuckle lime, the pool's main producing horizon, topped at 3,562 ft. (—1,718 ft.) and drilled to 3,591 ft. Hole then was plugged back to the Lansing-Kansas City, where casing, bottomed at 3,564 ft., was perforated at 3,282-89 ft. The well, which flowed 40 bbl. of oil the first hour before acidizing, and 250 bbl. in 4 hours after a 1,000-gal. acid treatment, established a state potential of 778 bb. of oil per day.

Discovery of the recently opened Fall Creek pool, near Caldwell, 4 miles north of the Oklahoma line, in Sumner County, is being confirmed by a second good well. The Texas Co. 2 Hoffisiefken, NE SW SW 3-35s-3w, a 10-acre location diagonally southwest of the discovery well, 1 Hoffisiefken, found the pool's Simpson pay zone, 2 ft. higher than in the discovery well. In a 24-minute drill-stem test at 4,700-10 ft. (surface elevation 1,125 ft.), the well filled with oil at the rate of 75 bbl. in 20 minutes and flowed the last minute the tool was open. Shut-in pressure built up to 1,850 psi. within 15 minutes. Casing has been run for completion.

KANSAS SUCCESSFUL WILDCATS

Seward County: Cities Service 1 Gaskill, NE NE SW 36-32s-33w, elev. 2,671 ft., 5,800,000 cu. ft. of gas from regular Hugoton pay, at 2,488-2,503 ft., TD 2,610 ft.

Sumner County: Texas Co. 1 Hobbisiefkin, SW NE SW 3-35s-3w, elev. 1,125 ft., flowed 24,406,000 cu. ft. of gas from 4,746-79 ft., TD; Stalnaker 3,120 ft., Layton 3,556 ft., Kansas City 3,608 ft., Marmaton 3,872 ft., Cherokee 4,020 ft., Mississippi lime 4,294 ft., Kinderhook 4,664 ft., Viola 4,708 ft., Simpson dolomite 4,728 ft., Simpson said 4,740 ft.

Woodson County: Rogers-Evans 1 Stockebrand, NE NE NW 28-23s-15e, pumped 18 bbl. of oil per day from 1,502-26 ft., TD; Mississippian 1,502 ft.

KANSAS WILDCAT FAILURES

Barton County: Honaker & Shields 1 Moran, SE SE NW 35-17s-11w, elev. 1,821 ft., dry, TD 3,335 ft., anhydrite 600 ft., Lansing-Kansas City 3,012 ft., Arbuckle 3,310 ft.

Musgrove 1 Mayback, NE NE SF 24-20s-14w, elev. 1,890 ft., dry, TD 3,593 ft., anhydrite 795 ft., Heebner 3,146 ft., Toronto 3,167 ft., lime 3,250 ft., Lansing-Kansas City 3,258 ft., Sooy 3,500 ft., Arbuckle 3,542 ft.

Welch-Olsson-Allison 1 Taylor, SE SE SW 18-19s-13w, elev. 1,860 ft., dry, TD 3,509 ft., Heebner 3,111 ft., lime 3,211 ft., Sooy 3,446 ft., Arbuckle 3,480 ft.

Butler County: Birmingham & Bartlett 1 Hinner "B," SE NE SW 7-24s-6e, elev. 1,404 ft., dry, TD 2,912 ft., Lansing 1,740 ft., Kansas City 2,032 ft., Mississippian 2,563 ft., Viola 2,771 ft., Simpson 2,825 ft., Arbuckle 2,890 ft.

Hager-Wakefield 1 Paulson, NE SW SW 36-23s-3e, elev. 1,376 ft., dry, TD 2,750 ft., Lansing 1,851 ft., Kansas City 2,102 ft., Mississippi lime 2,463 ft.

Clay County: Turner et al Concord, SW SE NE 24-8s-3e, elev. 1,297 ft., dry, TD 3,000 ft. in Simpson.

Cowley County: Wakefield et al 1 Curfman, NE NW NW 26-31s-4e, elev. 1,217 ft., dry, TD 2,995 ft., Stalnaker 1,750 ft., Bartlesville 2,874 ft., Chattanooga 2,983 ft.

Cooper et al 1 Ogilbee, SW NE NE 7-32s-4e, elev. 1,140 ft., dry, TD 2,032 ft., Stalnaker 1,960 ft., shale 2,030 ft.

Ellis County: Blair 1 Chesney, SW SW SE 17-11s-16w, elev. 1,758 ft., dry, TD 3,359 ft., anhydrite 955 ft., Topeka 2,666 ft., Heebner 2,926 ft., Toronto 2,951 ft., Lansing-Kansas City 2,967 ft., Sooy 3,259 ft., Simpson 3,323 ft., Arbuckle 3,338 ft.

Okmar 1 Gassoway, NE NE NW 11-11s-19w, elev. 2,107 ft., dry, TD 3,680 ft., anhydrite 1,440 ft., Topeka 3,068 ft., Heebner 3,291 ft., Lansing-Kansas City 3,332 ft., Arbuckle 3,662 ft.

Blair 1 Dodge, SE SE NE 29-12s-16w, elev. 2,111 ft., dry, TD 3,628 ft., anhydrite 1,300 ft., Topeka 3,017 ft., Heebner 3,290 ft., Lansing-Kansas City 3,335 ft., Sooy 3,560 ft., Arbuckle 3,597 ft.

Kingman County: Wakefield 1 Dewey, NW NW SW 12-29s-6w, elev. 1,487 ft., dry, TD 4,110 ft., Kansas City 3,427 ft., Mississippian 4,018 ft.

McPherson County: Beardmore 1 Hockstraser, NW NW SE 5-19s-14w, elev. 1,518 ft., dry, TD 3,915 ft., Kansas City 2,512 ft., Heebner 2,474 ft., Lansing 2,512 ft., Mississippi lime 3,147 ft., Kinderhook 3,447 ft., Viola 3,776 ft., Simpson shale 3,816 ft., Simpson sand 3,824 ft., Arbuckle 3,883 ft.

Marion County: Aladdin 1 Wallace, SE SE SW 34-21s-2e, dry, TD 3,307 ft., Howard 1,422 ft., Topeka 1,498 ft., Heebner 1,824 ft., basal Oread 1,878 ft., Lansing-Kansas City 2,104 ft., Burgess 2,717 ft., Sooy 2,726 ft., Mississippi chert 2,735 ft., Kinderhook 2,939 ft., Hunton 3,058 ft., Maquoketa 3,109 ft., Viola 3,135 ft., Simpson sand 3,194 ft., Arbuckle 3,257 ft.

Osborne County: Superior 54-2 Nagel, SW SW NE 2-9s-15w, elev. 1,914 ft., dry, strat test, no information released.

Pratt County: Lion Oil 1 Maercker, NE NE

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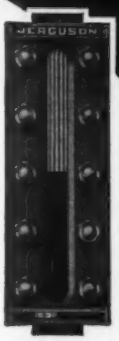

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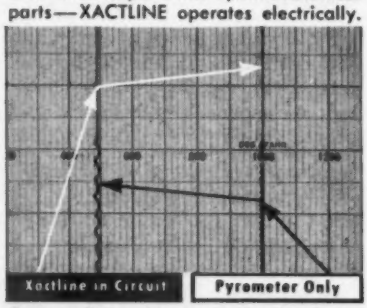

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Rooks County: Appleman 1 Carmichael, CSL SW SW 19-9s-17w, elev. 2,116 ft., dry, TD 3,683 ft., anhydrite 1,455 ft., Topeka 3,065 ft., Heebner 3,282 ft., Lansing-Kansas City 3,324 ft., Sooy 3,570 ft., Arbuckle 3,653 ft.

Westgate-Greenland 1 Ruder, SE NE SW 35-8s-18w, elev. 1,996 ft., dry, TD 3,560 ft., anhydrite 1,389 ft., Heebner 3,135 ft., Lansing-Kansas City 3,178 ft., Sooy 3,428 ft., Arbuckle 3,550 ft.

Sedgwick County: Pabco Drilling 1 Souders, SW SW NW 6-20s-4w, elev. 1,370 ft., dry, TD 4,485 ft., lime 2,991 ft., Lansing 3,101 ft., Kansas City 3,265 ft., Mississippi lime 3,872 ft., Kinderhook 4,143 ft., Simpson 4,345 ft., Arbuckle 4,449 ft.

Stafford County: Alpine 1 Dieker, SE SE NW 5-21s-12w, elev. 1,853 ft., dry, TD 3,505 ft., anhydrite 656 ft., Heebner 3,072 ft., lime 3,196 ft., Lansing-Kansas City 3,217 ft., Sooy 3,445 ft., Arbuckle 3,465 ft.

California

Wildcats Drilling in Oregon, Nevada and Arizona

LOS ANGELES.—Exploration operations in the West Coast area have expanded in recent weeks. Wildcats are under way in Oregon, Nevada, and Arizona. In Washington, where Union Oil Co. has drilled several tests in the past 2 years, operations temporarily have been abandoned.

In northeastern Nevada the joint test of Continental Oil Co. and Standard of California has reached a depth of below 6,350 ft. The wildcat, 1 Meridian Unit in Sec. 31-16n-56e, White Pine County, is scheduled to go below 8,000 ft. It is in the Pancake Range area 45 miles west of Ely.

A second Nevada wildcat is getting under way near Halleck, 20 miles east of Elko in the county of the same name. This test is to be drilled by McCarthy Oil Co., Elko, as the 1 Rahas. It is to be a deep test, using a rotary capable of drilling below 9,000 ft. These two wells are the first to be drilled in this part of the state.

Amerada Petroleum Co. and Stanolind Oil & Gas Co. have reached a depth of below 4,600 ft. at their wildcat in Apache County, Arizona. Known as the 1 Black Mountain the test is on the Navajo Indian Reservation about 13 miles northeast of Chinle, near the New Mexico State line.

After several months of attempting to establish commercial oil production at a wildcat near Ocean City, Wash., Union Oil Co. has suspended operations in that state. Its 3 State would pump from 6 to 15 bbl. daily of 39°-gravity crude after being closed in for several days, but Union was unable to make a well.

California operations.—Two developments in the Castaic area of northern Los Angeles County consisted of an offset being staked to Texas Co. 1 Honor Farm discovery and a small extension to the Castaic Junction field. The Honor Farm well will be a 950-ft. west offset to the discovery, completed last month for a 1,400-bbl. well in a 5,200-5,400-ft. sand.

At Castaic Junction, discovered by Humble Oil & Refining Co. in February, the field's second well was a northwest stepout. It was completed for 155 bbl. of 48.5°-gravity crude daily, flowing from a sand section perforated between 11,200 and 11,370 ft. Prior to completion Humble had extensively tested shallower and deeper oil shows.

In San Joaquin Valley a setback was given Kings County's new Hanford area, where Goshen Syndicate last July completed its 2 Drummond-Union for a 90-bbl. pumper at 5,404 ft. The southeast offset, 3 Drummond-Union, was abandoned at 6,080 ft.

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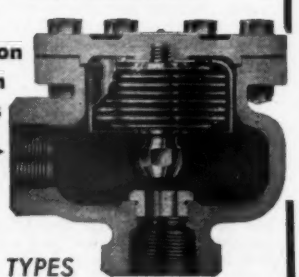

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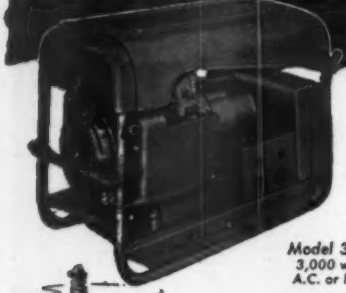

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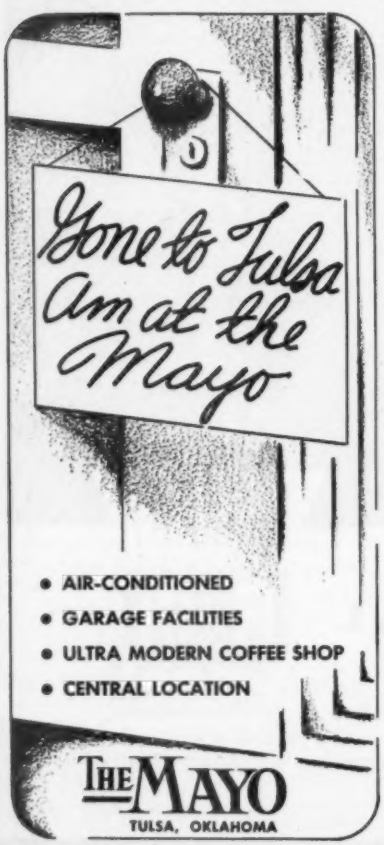

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Fairview Exploration Co. 1 Blake in the Carrizo plains area of Kern County reportedly found a fair oil showing at 1,350-1,660 ft. At the weekend casing was being run prior to testing shows. Located in Section 31-28s-19e, the wildcat is in an area where a half-dozen tests proved failures in the last 18 months.

CALIFORNIA SUCCESSFUL WILDCAT

Los Angeles County, Castaic Junction field: Humble Oil & Ref. Co. 2 NL&F, 14-4n-17w, completed for 159 bbl. per day rate of 48.5°-gravity crude from perforations at 11,200-11,370 ft., ½-in. flow bean, 2 per cent cut, 11,500-cu. ft. gas-oil ratio, tubing pressure 1,400 psi., TD 11,855 ft. plugged back to 11,480 ft., elev. 875 ft. Northwest stepout and second well in field.

CALIFORNIA UNSUCCESSFUL WILDCATS

Kern County, Devils Den area: The Texas Co. 1 Capital Co.-Two, 19-25s-19e, dry, TD 7,234 ft., elev. 475 ft.

Poso Creek area: Pacific Oil & Gas Dev. Corp. 62A Glide, 12-27s-27e, dry, bottomed in Vedder, TD 2,934 ft., elev. 1,113 ft.

Kings County, Hanford area: Goshen Syndicate 3 Drummond-Union, 36-18s-22e, dry, TD 6,080 ft., elev. 254 ft.

Merced County, Los Banos area: International Exploration Co. 1 Esther, 28-11s-10e, dry, TD 1,849 ft., elev. 350 ft.

Monterey County, Arroyo Seco area: Humble Oil & Rfg. Co. 1 C. N. Thorup, 21-19s-6e, dry, TD 7,651 ft., elev. 418 ft.

San Bernardino County, Cajon Pass area: Sierra Nevada Oil Co. 1 Yucca Comm., 1-3n-7w, dry, TD 5,700 ft., elev. 4,505 ft.

Rocky Mountain

New Oil Discovery for San Juan Basin Indicated

DENVER.—Possibility of a new oil discovery for the San Juan basin is indicated with tests of the Southern Union Producing Co. 1 Navajo, SW NE NE 1-21n-14w, San Juan County, New Mexico. Dakota was topped at 3,554 ft. and the well had shows of gas and oil between 3,645-50 ft., total depth. Casing was cemented on top the sand and the well filled to 1,300 ft. off bottom. Southern Union is now swabbing oil, an estimated 10 bbl. per hour, from that zone. There have been several tests to Dakota on the Stoney Butte structure and though shows of oil have been found in previous wells the present is the first indicating commercial possibilities. The oil is approximately 50° gravity.

A slight show of oil is reported at the General Petroleum Corp. wildcat in the Slick Creek area, Washakie County, Wyoming. The well is 84-32-G, SE SE NE 32-47n-92w. The Phosphoria was topped at 10,453 ft. and there was a slight show of oil and some gas logged in cores. General Petroleum is drilling below 10,544 ft. in the Phosphoria, with no test made of the zone. This wildcat is another in the series drilled by General Petroleum following seismic work through the southeastern part of the Big Horn basin. As a result of this drilling Phosphoria produces in two fields and Frontier in a third through this area south and east of the Worland field. At Worland substantial Phosphoria production has been established since discovery in 1946. Immediately south of the Worland field, General Petroleum made a small Phosphoria discovery in the South Frisby wildcat, completed last year. However, Phosphoria was hard and tight in that well.

Shell Oil Co. is drilling below 7,106 ft., headed for the Morrison, at its wildcat in the Buckingham area, eastern Weld County, Colorado. This well made water on drill-stem test in the Dakota sand, after finding oil in the Muddy zone. The well is 1 Hanson, NE NE NE 33-8n-59w, flowed 38°-gravity oil on tests of the Muddy between 6,715-26 ft. and is an apparent discovery in the new northeastern Colorado play. This will be Shell's first production in the Rocky Mountain region.

Gas has been tested in the Morrison at the Stanolind Oil & Gas Co. wildcat in Ignacio, La Plata County, Colorado, and the operator is coring ahead in that formation. The well is 1 Ute Indian, C SE NE 18-33n-7w, and the Morrison was topped at 7,580 ft. On drill-stem test 7,578-7,720 ft., with tool open 3 hours, there was a good flow of gas with volume estimated at more than 10 M.M.c.f. daily. Bottom-hole pressure was 3,440 psi. on the test. The Morrison is reported quartzitic with fractures, and drilling through the zone has been 20 to 30 minutes per foot. The Dakota zone, topped at 7,360 ft., was also highly quartzitic and no shows were reported. However, in the Fruitland and Pictured Cliffs zones this well had in excess of 10 M.M.c.f.

WYOMING WILDCAT SUCCESS

Happy Springs, Fremont County: Sinclair Oil & Gas Co. 2 Unit, SW NW SW 16-28n-93w, 6,084 ft. T.D., swabbed 525 bbl. oil per day from Frontier formation. Cody 1,155 ft., Shannon 3,143 ft., Niobrara 5,116 ft., Frontier 5,328 ft., basal Frontier 5,904 ft., Mowry 6,072 ft.

WYOMING WILDCAT FAILURE

Kara area, Weston County: National Associated Petroleum Co., SW SW NW 18-48n-66w, 5,270 ft. TD, Pierre 700 ft., Niobrara 2,574 ft., Fort Hayes 3,411 ft., Carlisle 3,466 ft., no Wall Creek, no Newcastle, Dakota 5,259 ft., dry.

COLORADO WILDCAT SUCCESS

Loveland, Weld County: W. E. Atkinson-C. S. Lavington 1 Caldwell, C SE SW 30-5n-68w, 1,492 ft. TD, flowed 1,530 M.c.f. gas daily from sand in Hygiene, 4½-in. casing at 1,490 ft.; perf. 1,432-43 ft.

MONTANA WILDCAT FAILURES

Sage Hen, Garfield County: Seaboard Oil Co. of Delaware 7-30-G, NW SW SW 30-14n-32e, 5,131 ft. TD, Blackleaf 1,135 ft., first Cat Creek 2,188 ft., Kootenai 2,287 ft., second Cat Creek 2,438 ft., third Cat Creek 2,525 ft., Morrison 2,660 ft., Morrison sand 2,717 ft., Ellis 2,825 ft., Gypsum Springs 3,185 ft., Amsden 3,315 ft., Heath 3,435 ft., Otter 3,910 ft., Charles 4,074 ft., Madison 4,984 ft., dry.

Garneil area, Judith Basin County: T. W. Doswell 1 Dolgan, NE NW SE 12-11n-15e, 4,822 ft. TD, Morrison 250 ft., Ellis 445 ft., Amsden 515 ft., Heath 775 ft., Otter 895 ft., Kibbey 1,305 ft., Charles 1,550 ft., Madison 2,320 ft., Lodgepole 2,620 ft., Three Forks 3,205 ft., Jefferson dolomite 3,290 ft., Big Horn 3,420 ft., Meagher lime-Cambrian 4,404 ft., Flathead sand 4,806 ft., dry.

Devon gas area, Toole County: Linville & Smith 1 McCarter Bros., C NW SW 33-32n-3e, 1,010 ft. TD, suspended indefinitely.

Galata, Toole County: Linville & Smith 1 Flage, NW NW SE 4-31n-3e, 600 ft. TD, suspended indefinitely.

NORTHERN NEW MEXICO WILDCAT FAILURE

Chama area, Rio Arriba County: O. A. Larrazola 3 Chama Land & Cattle, C SW NE 29-31n-4e, 350 ft. TD, Dakota 235 ft., Morrison 340 ft., dry.

NEBRASKA WILDCAT FAILURES

McCourt area, Cheyenne County: Ohio Oil Co. 1 Thompson, SE SE NW 21-16n-47w, 4,647 ft. TD, Niobrara 3,314 ft., Fort Hayes 3,584 ft., Codell 3,689 ft., Greenhorn 3,853 ft., first Dakota 4,086-4,143 ft., dry.

Hyannis area, Grant County: Oil Hunters, Inc. 1 Farrar, NE NE NW 9-21n-38w, 4,688 ft. TD, Niobrara 1,905 ft., Fort Hayes 2,181 ft., Codell 2,247 ft., Greenhorn 2,401 ft., first sand 2,620 ft., Morrison 3,432 ft., Spearfish 3,460 ft., anhydrite 3,945 ft., granite 4,687 ft., dry.

Illinois-Ind.-Ky.

Two Wells Prove New Henderson County Pool

OPENED the past week, the new pool located in the area 2 miles east of Zion and about 7 miles east of Henderson in north central Henderson County, western Kentucky, already has received confirmation of its discovery with the completion of a second good producer. The area is about 1¼ miles southeast of the Zion pool, nearest production.

Both wells produce from McClosky lime. The new discovery well, Hupp & Hume and associates 1 Pinkerton-Blair, NW SW SW 2-P-25, completed with casing perforated in that zone at 2,158-72 ft., flowed at the rate of 425 bbl. of oil per day. Total depth is 2,180 ft. with casing cemented on bottom.

Acme Drilling Co. and associates 2 Neal, SW NW SW 2-P-25, a direct north offset to the discovery well, flowed initially at the rate of 700 bbl. of oil daily. It is producing from an interval at 2,152-62 ft. with bottom of the hole at 2,182 ft.

Confirmation and extension of production discovered by Skiles Oil Corp. last month in the area 2 miles southwest of Goldengate, southeastern Wayne County, Illinois, and 2 miles northeast of nearest production in the Goldengate pool, and are being given by two additional wells which have found good saturation in the new pool's pay zones. The same operator's 1 Etheridge, NE NW SW 23-2s-9e, southeast offset to the discovery well, 1 Allison, SW SW NW 23-2s-9e, has run casing to test the O'Hara at 3,272-80 ft. and the Rosiclare at 3,297-3,307 ft. A drill-stem test of the latter zone had gas at the top within 5 minutes, and in the pipe break-down 3,100 ft. of clean oil, 60 ft. of oil-cut mud and 60 ft. of salty mud was recovered. The O'Hara was not tested but it carried excellent saturation. The discovery well is producing from the O'Hara at 3,274-90 ft. and the Rosiclare at 3,306-10 ft.

One-half mile southwest of the Skiles wells, Aurora Gasoline Co. and associates appear to have a good producer in the O'Hara zone at their 1 Scott, NE NE NE 27-2s-9e. Casing, run through the zone to 3,335 ft., is perforated at 3,292-3,303 ft. In a drill-stem test of this zone, taking in an interval at 3,287-3,301 ft., the well flowed clean oil. Oil was at the surface within 11 minutes after the tool was opened. Gas showed within 3 minutes. Indicated bottom-hole pressure was 1,100 psi.

Ryan Oil Co. 1 Morrill, NW NW SW 11-6s-9e, an outpost location on the west side of the Storms pool, White County, Illinois, swabbed at the rate of 100 bbl. of oil per day. In addition to being an outpost, it proves a new Cypress sand zone for the general area. Sand is at 2,760-69 ft. with hole open below 2,749 ft. to total depth at 2,781 ft. The area is 5 miles south of Carmi.

ILLINOIS WILDCAT FAILURES

Clay County: Superior Oil Co. 1 Klein, NE SE NE 31-3n-7e, dry, TD 3,155 ft.

Clinton County: L. P. Halst 1 Fruend, NE NW NE 30-2n-1w, dry, TD 570 ft.

Cumberland County: T. S. Doran et al. 1 Fogleman, SW SE NE 21-9n-9e, dry, TD 2,884 ft.

Effingham County: Mark Twain Oil Co. 1 Hinger, SW SE SW 26-7n-4e, dry, TD 2,460 ft.

Gallatin County: J. B. Buchman 1 Decker, NE SE SE 12-8s-10e, dry, TD 2,985 ft.

Lawrence County: F. R. Stocker 1 Rodgers, CSL SE NW SW 16-2n-12w, dry, TD 2,180 ft.

Morgan County: G. D. Whiteside 1 Ladade, Jr., SW SE SE 13-13n-8w, dry, TD 1,145 ft.

Pike County: C. Measley 1 Williams, NE NW NE 12-3s-2w 4th P.M., dry, TD 451 ft.

Wabash County: Continental Drilling Corp.

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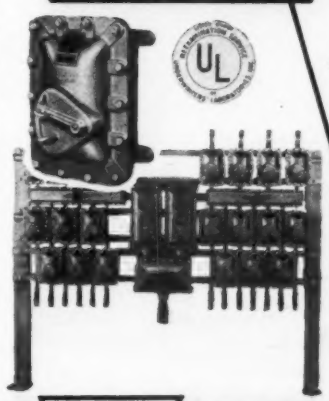

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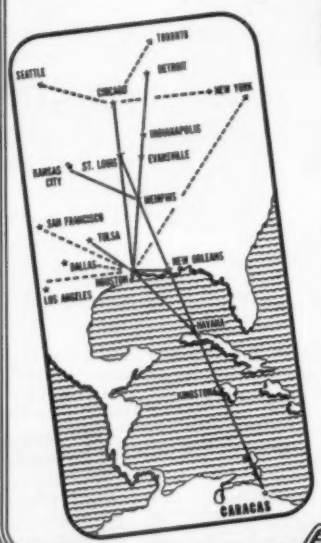

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1 Parkinson, SW SW NE 32-2n-11w, dry, TD 2,574 ft.

Wayne County: Robinson & Puckett 1 Clark, NW SW SW 8-2s-7e, dry, TD 3,420 ft.

White County: Skiles Oil Corp. 1 Delap, NE NE SE 28-6s-8e, dry, TD 3,133 ft.

Don Slope 1 Murphy, SW SW SE 1-4s-9e, dry, TD 3,400 ft.

INDIANA WILDCAT FAILURES

Daviess County: Sohio Petroleum Co. 1 Bowman, SW SW NE 9-4n-6w, dry, TD 2,218 ft.

Gibson County: Hayes Drilling Co. 1 Antell, NW NW SE 3-2s-9w, dry, TD 1,722 ft.

Vigo County: Carter Oil Co. 1 Nevin, SE cor. SE SE NE 31-13n-7w, dry, TD 1,497 ft.

WESTERN KENTUCKY WILDCAT FAILURES

Daviess County: Chester Oil Co. et al. 1 Barrett, SW cor. NE SW SW 19-O-31, dry, TD 1,372 ft.

McLean County: Basin Drilling Co. et al. 1 Glover, NE NE NE 35-N-27, dry, TD 2,521 ft.

EASTERN KENTUCKY

ASHLAND.—Location for a new wildcat in Magoffin County has been staked by Bed Rock Petroleum Co. Test is situated on Middle Fork in the southern tip of the county and will be known as the Courtney Arnett No. 1. It is several miles south of production in the Royalton pool which produces from the Big Six (Silurian) sand.

In Pike County sector of Big Sandy gas field, Kentucky West Virginia Gas Co. completed 5,933 J. Lee Ferguson for 273,000 cu. ft. of gas daily from Devonian black shale, after shot, at a total depth of 4,042 ft.

In Johnson County 7-R-79 Ashland Oil & Refining Co. had Big Injun sand at 600 ft. and was drilling ahead at 728 ft. on 3 S. Q. Kelly southwest outpost to Martha pool.

Canadian Fields

Big Valley D2 Discovery Is Getting Thorough Test

CALGARY.—Latest drill-stem test at Canadian Gulf Oil Co.'s Big Valley discovery well flowed oil to the surface, but also gave an indication that the water line may have been encountered. A further test was expected to be run as soon as possible to confirm or deny the D2 oil-water interface. If the water line has been encountered, the Big Valley oil discovery is assured of at least 28 ft. of highly productive D2, with probability of close to 39 ft. of pay above water.

The 7 Gulf-Big Valley, in LSD 7, 10-35-20w4, ran a 2-hour and 14-minute test from 5,268-79 ft. and received a flow of natural gas 3 minutes after the valve was opened, and a flow of oil in 39 minutes. Oil flow rate was not measured, but when pipe was pulled there was about 3 gal. of salty sulfur water in the bottom. Hole has since been cored to 5,284 ft., and another test is to be run immediately.

The D2 zone of Devonian at the Big Valley well was topped at 5,240 ft. If the water line has been established, the well will be carried down in search of D3 Devonian. However, coring and testing in D2 will continue until the full thickness of D2 pay zone is determined.

The Big Valley strike is located about 17½ miles south of Gulf's Stettler Devonian oil production, and around 80 miles northeast of Calgary. Gravity of the Big Valley crude is around 33.1°.

Socony-Vacuum Exploration Co. has completed drilling at its dual-zone Devonian oil discovery well 12 miles southwest of Camrose, and has set casing, preliminary to readying the well for steady production. The well is 1 Socony-Flint, in LSD 13 17-45-21w4. The well showed between 30 and 35

ft. of D2 zone oil pay, and between 27 and 32 ft. of D3 zone oil pay. Gravity of the oil is between 34° and 35°.

Central Leduc Oils, Ltd., of Calgary, found some gas and oil encouragement in D2 zone of Devonian at its Lower Cretaceous oil-discovery well in the Stony Plain area of central Alberta. Hole is now proceeding in search of D3 Devonian zone, with answer in that horizon expected this week.

The well, 1 Central Leduc-Wild, in LSD 12 27-52-25w4, ran D2 drill-stem test at 4,784-92 ft. In 90 minutes the well obtained a gas flow rate of 100,000 cu. ft. daily, with gas blow starting as soon as tester was opened. Pipe recovery was 140 ft. of light brown crude oil, 20 ft. of mud, and 10 ft. of water. Drilling is now proceeding below 5,095 ft., heading for D3 Devonian.

CANADIAN SUCCESSFUL WILDCAT

Canadian Superior-Crown No. 1-5, LSD 1 5-29-9w4, TD 4,265 ft., IP 4,710,000 cu. ft. natural gas daily.

CANADIAN UNSUCCESSFUL WILDCATS

McCarty & Coleman-Red Deer Lake No. 1, LSD 1 12-44-21w4, TD 5,905 ft.

Pacific-Fina-Bradley No. 1, LSD 1 35-70-2w5, TD 3,337 ft.

Great Plains-Seaboard-Smokey Lake No. 1, LSD 16 5-59-17w4, TD 3,375 ft.

Louisiana-Arkansas

Shallow Wildcat Completed In Bienville Parish

SHREVEPORT.—E. C. Cook and associates 1 W. C. Locke, shallow wildcat in 9-15n-10w, Bienville Parish, completed as a Paluxy discovery, flowing 68 bbl. of 41.7°-gravity oil a day. Production was through ½-in. tubing choke, from open hole at 2,782-2,800 ft. The Paluxy was entered at 2,756 ft., on elevation of 185 ft. Location is 4 miles south of Bistineau gas field.

In Caddo Parish, J. D. Collins 1 W. A. Caplis, 33-16n-12w, was dry at 4,562 ft., in the Rodessa. A small amount of gas was swabbed from open hole at 4,506-62 ft.

Skelly Oil Co. 1 R. B. Williamson, Cotton Valley wildcat located on a subsurface prospect in 9-19n-16w, 2 miles west of Mooringsport field, was drilling ahead at 4,790 ft. in the lower Cretaceous. A 1-hour drill-stem test from 3,715-30 ft., in the Mooringsport zone, recovered 30 ft. of mud and 90 ft. of salt water.

In Catahoula Parish, 4 miles south of Saline Lake field, Hunt Oil Co. 28 Louisiana Delta, 30-4n-5e, was pulling tools after a drill-stem test from 6,276-84 ft. Total depth was 7,500 ft., in the Wilcox.

Ray & Wolf 1 K. R. English, new Travis Peak wildcat northwest of Lisbon field in 8-21n-5w, Claiborne Parish, was drilling shale at 5,179 ft.

Stanolind Oil & Gas Co. 1 Meadors, 8-22n-5w, deep Claiborne wildcat, was coring the Smackover limestone at 11,662 ft. Recovery from 11,370-11,662 ft. was dense lime, siltstone, and shale with no shows. Top on the Smackover was 10,692 ft., by samples, on elevation of 267 ft.

Carnes & May 1 Clark, 7-15n-8e, Franklin Parish, was waiting on cement after squeezing perforations from 3,829-30 ft., which had not been tested. Perforations from 3,851-60 ft. yielded salt water with a slight oil show. Total depth was 4,410 ft. in the lower Cretaceous.

In Sabine Parish, Grace Drilling Co. 1 Southern Advance Paper Co., 33-8n-10w, was drilling sand and shale of lower Cretaceous age at 5,750 ft. Projected depth was 7,000 ft.

ARKANSAS WILDCAT FAILURE

Union County: Marine Oil Co. 1 Johnson, NW SW NE 33-17s-12w, dry, TD 5,306 ft., elev. 162 ft., Saratoga 2,535 ft., base Annona 2,695 ft., Graves 2,815 ft., Travis Peak 2,958 ft., Cotton Valley 4,007 ft.

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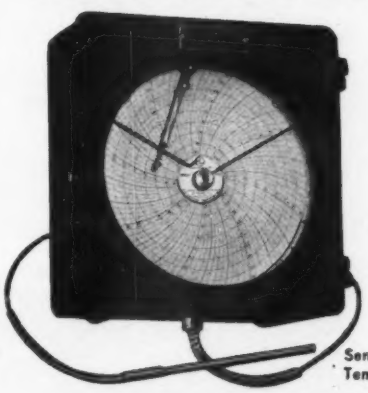

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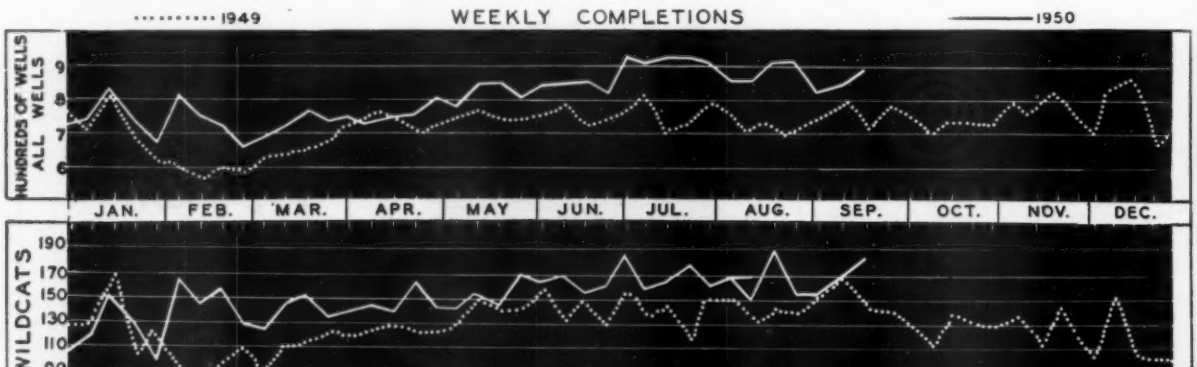
CURRENT STATISTICS

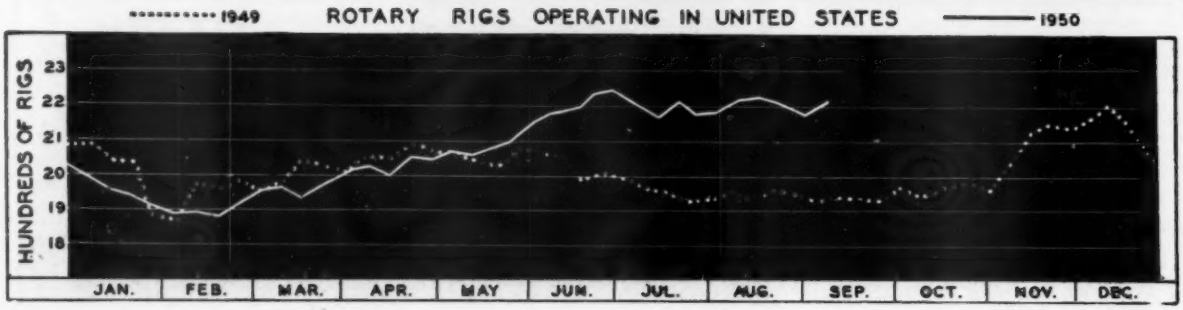
EXPLORATION

WEEKLY WELL COMPLETIONS . . . WEEK ENDED SEPTEMBER 16, 1950

	Total of all wells					Sept. 16		Wildcat completions and discoveries					Cumulative total, 1950				
	Comp.	Oil	Gas	Dry	Footage	1950	1949	Oil	Dist.	Gas	Dry	Total	Oil	Dist.	Gas	Dry	Total
New York	17	9	0	*8	24,752	483	732	0	0	0	0	0	0	0	0	0	0
Pennsylvania	17	8	1	†8	27,305	934	1,160	0	0	0	0	0	0	0	1	2	3
West Virginia	11	2	6	3	35,521	475	358	0	0	1	1	2	0	0	15	16	31
Ohio	21	6	6	‡9	42,816	701	785	0	0	0	0	0	1	0	2	8	11
Indiana	28	11	0	17	46,218	1,169	948	0	0	0	3	3	40	0	1	191	232
Kentucky	23	9	6	8	47,088	805	671	0	0	0	2	2	19	0	1	66	86
Illinois	77	33	0	44	184,407	1,937	1,797	0	0	0	12	12	39	0	1	429	469
Michigan	17	4	0	13	39,235	619	708	1	0	0	10	11	23	0	4	210	237
Kansas	87	32	11	44	252,403	2,664	2,302	1	0	2	20	23	70	0	10	440	520
Nebraska	4	2	0	2	18,706	83	19	0	0	0	2	2	6	0	1	39	46
Oklahoma	122	76	4	42	447,509	3,845	3,072	5	0	1	17	23	119	6	15	475	615
Texas	343	207	7	129	1,587,597	11,562	9,565	7	0	2	72	81	359	29	83	1,830	2,301
North Central (Dist. 7-B & 9)	83	45	2	36	265,501	3,487	3,180	2	0	2	21	25	157	2	22	716	897
West (Dist. 7-C & 8)	118	90	0	28	582,297	3,485	2,280	2	0	0	16	18	70	2	4	347	423
Panhandle (Dist. 10)	0	0	0	0	0	637	683	0	0	0	0	0	1	0	2	13	16
Eastern (Dist. 5, 6, & 6-P)	21	17	0	4	109,520	829	596	3	0	0	2	5	13	4	3	140	160
Gulf Coast (Dist. 2 & 3)	70	37	3	30	424,622	1,640	1,429	0	0	0	10	10	62	12	29	271	374
Southwest (Dist. 1 & 4)	51	18	2	31	205,657	1,484	1,397	0	0	0	23	23	56	9	23	343	431
Louisiana	33	19	2	12	214,661	1,724	1,644	1	0	0	4	5	35	15	5	143	198
Northern	15	10	1	4	56,516	925	962	0	0	0	0	0	5	3	2	63	73
Southern	18	9	1	8	158,145	799	682	1	0	0	4	5	30	12	3	80	125
Arkansas	8	6	0	2	22,813	292	234	0	0	0	1	1	9	0	0	70	79
Mississippi	5	2	0	3	35,973	230	247	0	0	0	1	1	8	2	0	82	92
Southeastern States	2	0	0	2	9,959	46	36	0	0	0	2	2	1	0	1	26	28
Montana	25	16	1	8	48,977	175	192	0	0	0	4	4	1	0	0	30	31
Wyoming	10	7	0	3	46,987	408	426	1	0	0	1	2	17	0	0	54	71
Colorado-Utah	2	0	2	0	11,333	59	103	0	0	1	0	1	4	0	1	37	42
New Mexico	10	7	1	2	16,682	437	365	0	0	0	1	1	10	1	0	40	51
California	36	29	1	6	177,063	1,263	1,857	1	0	0	6	7	19	0	3	268	290
Miscellaneous	0	0	0	0	0	36	15	0	0	0	0	0	0	0	0	11	11
Total United States	898	485	48	365	3,338,005	29,947	27,236	17	0	7	159	183	780	53	144	4,467	5,444
Total previous week	850	449	73	328	3,184,530	....	....	24	2	13	130	169	763	53	137	4,308	5,261
Total September 16, 1950	711	373	68	270	2,432,126	....	....	19	1	5	115	140	681	64	142	3,968	4,855

Service wells included: *8, †7, ‡1.





DAILY AVERAGE PRODUCTION FOR WEEK

	Sept. 16 crude oil	B. of M. Sept. demand	Sept. 9 crude oil
Alabama	2,250	1,600	2,100
Arkansas	81,050	90,000	82,550
California	905,400	928,000	902,300
Colorado	61,900	67,000	63,400
Eastern	61,000	65,000	61,600
Florida	1,750	1,400	1,750
Illinois	181,900	188,000	180,800
Indiana	29,900	31,000	32,700
Kansas	305,150	306,000	277,200
Kentucky	27,300	30,000	28,300
Louisiana	578,000	590,000	579,800
North Louisiana	115,450	.....	117,250
South Louisiana	462,550	.....	462,550
Michigan	44,500	47,000	42,800
Mississippi	107,700	120,000	105,400
Montana	24,300	24,000	24,200
Nebraska	3,200	3,000	3,200
New Mexico	136,625	154,000	136,625
Oklahoma	463,200	460,000	470,350
Texas	2,663,550	2,260,000	2,663,550
Dist. 1 (Southwest)	30,800	.....	30,800
Dist. 2 (Southwest)	150,950	.....	150,950
Dist. 4 (Southwest)	235,250	.....	235,250
Dist. 3 (Gulf Coast)	454,625	.....	454,625
Dist. 5 (Eastern)	44,075	.....	44,075
Dist. 6 (Eastern)	104,250	.....	104,250
East Texas field	305,400	.....	305,400
Dist. 7-C (West)	66,450	.....	66,450
Dist. 8 (West)	948,700	.....	948,700
Dist. 7-B (W. Central)	75,150	.....	75,150
Dist. 9 (Central)	156,500	.....	156,500
Dist. 10 (Panhandle)	91,400	.....	91,400
Utah	3,600	4,000	3,500
Wyoming	164,100	170,000	163,900
Total United States	*5,846,375	5,540,000	5,826,025
Change from previous week, up	20,350		
Canada	101,600	.....	65,985

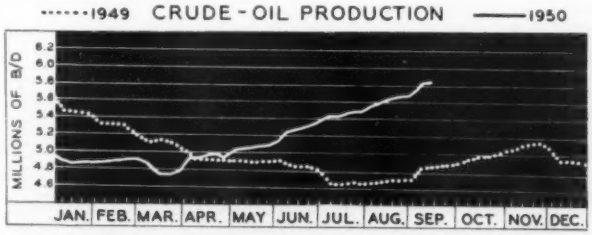
Total U. S. production January 1-September 16 †1,359,250,130 bbl.
Same period last year (crude plus cond.) ... 1,312,902,805 bbl.

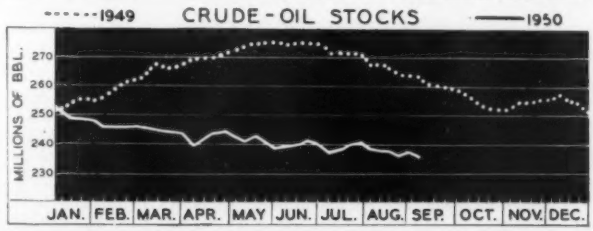
*Not including 96,250 bbl. condensate. †Including 25,192,755 bbl. condensate.

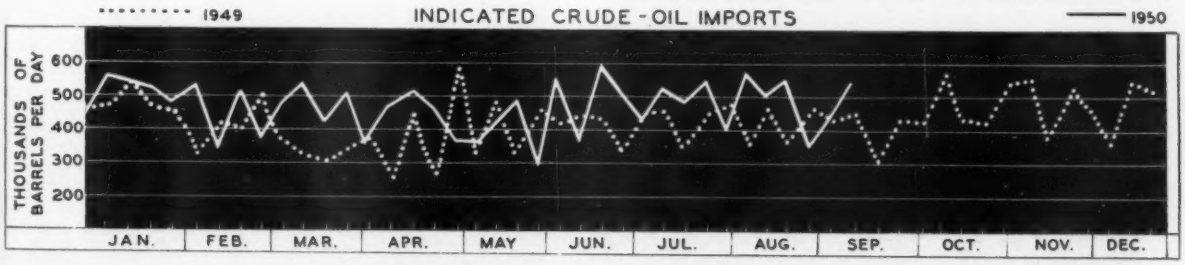
CRUDE-OIL STOCKS BY STATES OR ORIGIN*
(Thousands of barrels)

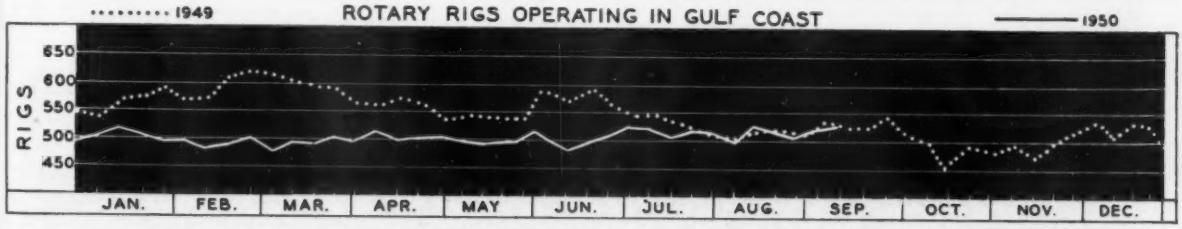
	Sept. 9, 1950	Sept. 2, 1950	Sept. 10, 1949
Pennsylvania Grade	2,449	2,554	3,303
Other Appalachian	1,398	1,353	2,354
Illinois, Indiana, Michigan	9,590	9,662	13,186
Arkansas	2,903	2,900	2,720
Louisiana	14,459	14,609	14,532
North	3,153	3,173	3,573
Gulf	11,306	11,436	10,959
Mississippi	2,615	2,485	2,629
New Mexico	6,030	5,908	7,535
Oklahoma and Kansas	33,852	33,501	38,892
Texas	114,767	115,937	118,235
East Texas	14,256	14,844	16,473
West Texas	44,967	44,207	47,363
Texas Gulf	28,171	28,912	27,804
Other Texas	27,373	27,974	26,595
Rocky Mountain	10,776	10,843	13,915
California	31,385	32,529	36,070
Foreign	6,214	5,825	7,765
Total	236,438	238,106	261,136

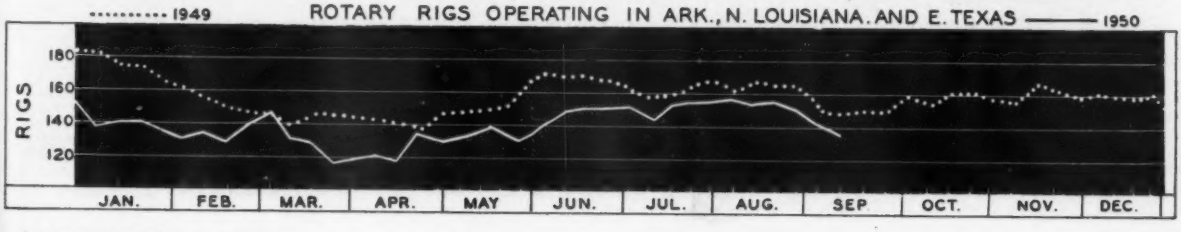
*Bureau of Mines.







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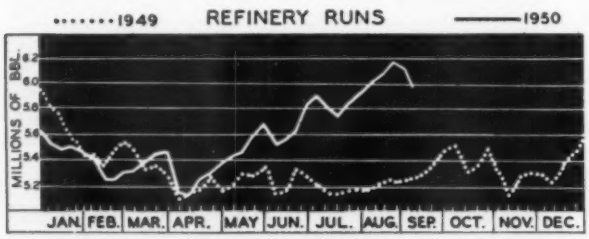
RIGS
180
160
140
120
JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP OCT. NOV. DEC.

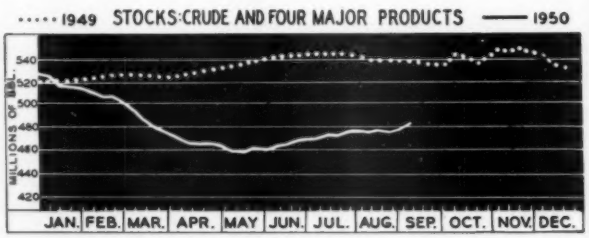
XUM

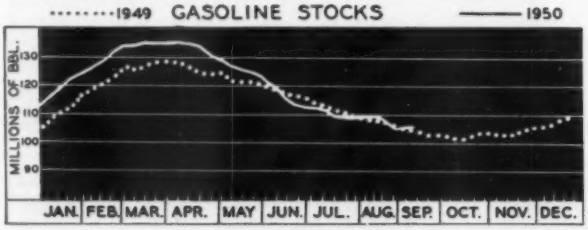
A.P.I. REFINERY REPORT, SEPTEMBER 9
(Thousands of barrels)

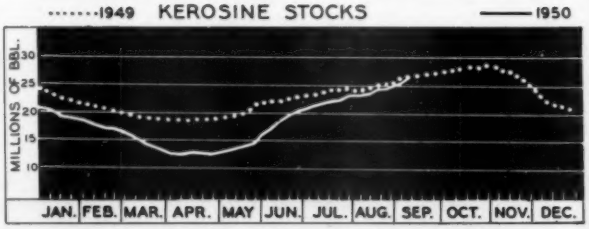
District—	Daily avg. crude runs	Daily average production				Stocks at refineries, bulk terminals, in transit and in pipe lines				Bureau of Mines, September 1949				
		Gasoline*	Kerosine	Distillate	Residual	Gasoline†	Kerosine	Distillate	Residual	Daily avg. crude runs	Daily average production: Gasoline*	Kerosine	Distillate	Residual
East Coast	951	374.3	38.0	198.7	209.9	24,697	9,479	20,298	11,302	777	319.8	25.4	172.3	176.9
Appalachian:														
District 1	113	42.9	6.7	13.0	10.1	2,403	443	665	443	98	46.9	5.0	13.2	10.0
District 2	77	34.1	3.3	5.9	13.1	1,111	150	197	238	67	35.1	4.1	7.2	13.6
Ind., Ill., Ky.	983	516.0	56.6	158.9	142.6	21,906	5,557	12,191	4,378	925	504.7	57.6	126.8	142.0
Okla., Kans., Mo.	510	284.3	15.7	109.1	59.9	10,337	1,401	7,339	1,370	418	241.6	14.4	82.1	60.9
Inland Texas	215	136.0	11.4	28.4	31.6	3,249	572	1,359	765	214	140.5	10.4	27.9	42.4
Texas Gulf Coast	1,425	663.7	119.5	293.0	263.7	16,830	4,464	10,629	6,096	1,325	606.1	81.4	282.0	233.8
La. Gulf Coast	484	246.2	43.7	125.9	66.0	6,369	2,662	3,757	2,191	456	220.8	47.2	106.3	60.8
N. La. and Ark.	55	21.7	4.4	8.0	7.1	2,174	611	691	242	73	30.9	6.3	10.6	15.0
Rocky Mountain:														
New Mexico	12	6.1	.4	2.1	3.3	89	25	42	35	10	5.8	.2	1.7	2.6
Other Rocky Mtn.	210	89.0	5.0	35.9	38.1	3,309	512	2,061	791	194	89.9	5.7	34.9	33.6
California	936	385.0	5.6	148.4	338.2	13,907	764	12,368	14,876	870	375.1	12.1	136.6	318.4
September 9, 1950	5,971	2,799.3	310.3	1,127.3	1,183.6	106,381	26,640	71,597	42,727	5,427	2,617.2	269.8	1,001.6	1,110.0
September 2, 1950	6,109	2,881.6	330.0	1,117.9	1,174.1	105,563	25,670	69,179	41,437	.....	.....	.....	.....	.....
September 10, 1949	5,248	2,610.0	284.6	922.1	1,115.4	104,375	26,608	78,231	69,161	.....	.....	.....	.....	.....

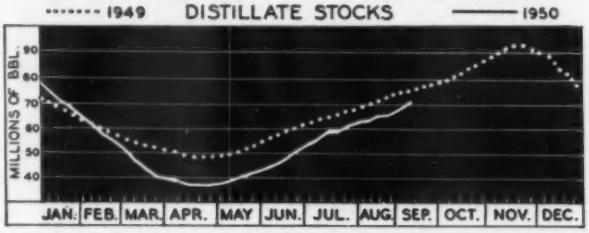
*At refineries including natural blended. †Finished and unfinished.

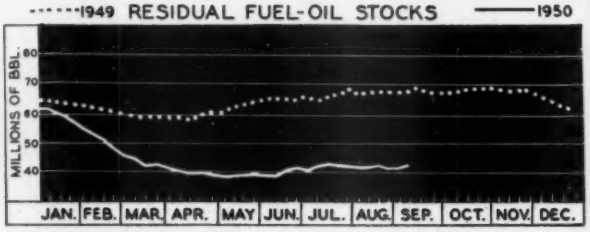


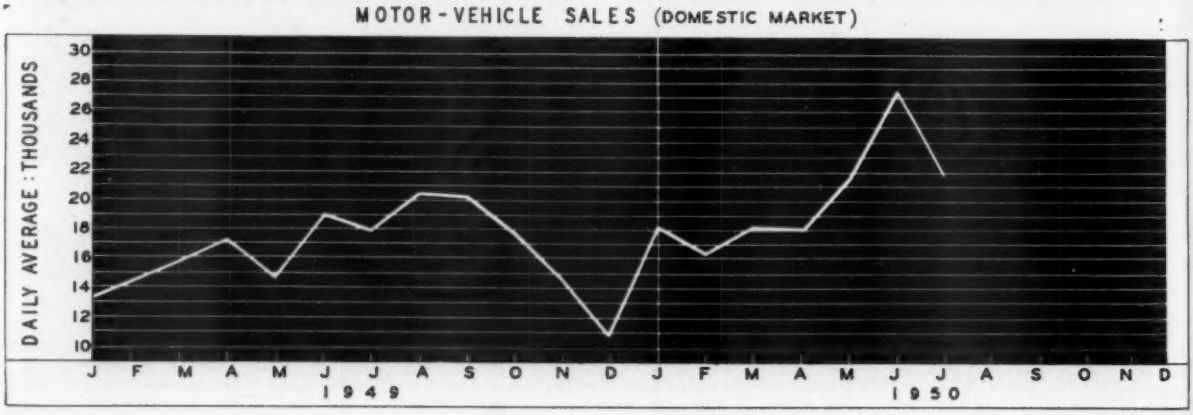












CRUDE PRICES

GRAVITY SCHEDULE

Gravity—	Signal Hill, Calif.	Oklahoma, Kansas	Gulf Coast Tex.*	West Tex.†
18-18.9	$1.69	....	....	....
19-19.9	1.77	....	....	....
20-20.9	1.85	$2.25	....	$2.12
21-21.9	1.93	2.27	....	2.14
22-22.9	2.00	2.29	....	2.16
23-23.9	2.08	2.31	....	2.18
24-24.9	2.15	2.33	$2.56	2.20
25-25.9	2.23	2.35	2.58	2.22
26-26.9	2.31	2.37	2.60	2.24
27-27.9	2.37	2.39	2.62	2.26
28-28.9	2.42	2.41	2.64	2.28
29-29.9	2.48	2.43	2.66	2.30
30-30.9	2.54	2.45	2.68	2.32
31-31.9	2.59	2.47	2.70	2.34
32-32.9	2.64	2.49	2.72	2.36
33-33.9	....	2.51	2.74	2.38
34-34.9	....	2.53	2.76	2.40
35-35.9	....	2.55	2.78	2.42
36-36.9	....	2.57	2.80	2.44
37-37.9	....	2.59	2.82	2.46
38-38.9	....	2.61	2.84	2.48
39-39.9	....	2.63	2.86	2.50
40 and above	....	2.65	2.88	2.52

*For crude from Daboval, El Campo, and Sand Point.

†Includes Lea County, New Mexico. Last general price change represented a 50-cent increase becoming effective December 6, 1947.

FLAT CRUDE PRICES

Representative posted schedules per barrel.

East Texas†	$2.65
Kettleman Hills, California*	2.77
Beauregard Parish	2.60
Illinois Basin	2.77
Pecos County, Texas (Yates)	2.35
Bradford, Pennsylvania	4.00
Eastern Ill. and Western Ind.†	2.77
Tomball, Texas Gulf Coast	2.83

*37°-37.9°. †35° and above.

DISTILLATE fuels for home heating are in a tug-of-war period on Gulf and East Coast markets. With good prospects for high demands during the coming heating season, Gulf Coast suppliers are reluctant to sell No. 2 fuel at the low of 7.5 cents a gallon. Most of the surplus production of the area must move to the East Coast with current tanker rates slightly above 1 cent a gallon. This means that spot material cannot move to New York Harbor and sell for the generally posted price of 8.5 cents. On the other hand, recent distillate movement out of primary storage has dropped off from the July-August rate. Most marketers feel that the decline has been due to the fact that many reseller and consumer tanks were filled by the end of August.

Indicated demand at Gulf - East Coast refineries for distillate fuels in the 4-week period ended September 9 was 11.6 per cent less than in the same weeks last year. Primary distillate stocks located in these districts increased 5,378,000 bbl. in 4 weeks compared with a gain of only 1,062,000 bbl. in the same weeks of 1949. Despite these additions to primary storage, market observers on the East Coast are expecting price increases on the New York Harbor distillate market.

Major suppliers at the week end had not met the 10-cent increase in residual fuel prices on the New York Harbor spot market. Total residual stocks increased 1,290,000 bbl. for the week ended September 9 with most of the gain on the Gulf Coast.

The strong natural-gasoline market continued with Group 3 and North Texas prices up 0.125 cent a gallon. Grade 26-70 is still 2.25 cents below the price laid throughout most of 1948 on the Group 3 market. Some Mid-Continent refiners are having to hunt natural for blending.

REPRESENTATIVE QUOTATIONS

Representative spot-market quotation of leading suppliers as a September 18, 1950. Figures are f.o.b. plant for tank-car shipments in cents per gallon, except for residual fuel oil which shows the price per barrel and wax, in cents per pound.

GASOLINE, KEROSINE, AND FUEL OILS

	Mid-Continent Group 3	New York Harbor (barge)	Texas Gulf Coast
Regular gasoline, 80-82 octane	10⅜-10½	12.5-12.75	10¾-11½
Premium gasoline, 86-88 octane	11¼-11½	13.5-13.75	11½-12
42-44 w.w. kerosine	8⅞-9	9.5	8½-8¾
No. 2 straw fuel oil	8⅛-8¼	8.5	7½-7¾
No. 6 residual	$1.65-1.75	$2.15-2.25	$1.80-1.85

NATURAL GASOLINE

	Group 3	North Texas	N. La.
Grade 26-70	6¼	5¾	6
Grade 18-55	7.5	7.0	7.25

LUBRICATING OILS

South Texas

200 vis., No. 2-3 neutral	12.5
750 vis., No. 3-4 neutral	14.75
2,000 No. 5-6 neutral	16.5

LUBRICATING OILS

Mid-Continent

150-160 vis., D bright stock, 0-10 pp.	26-27
200 vis., No. 3 neutral, 0-10 pp.	15.5-17.5

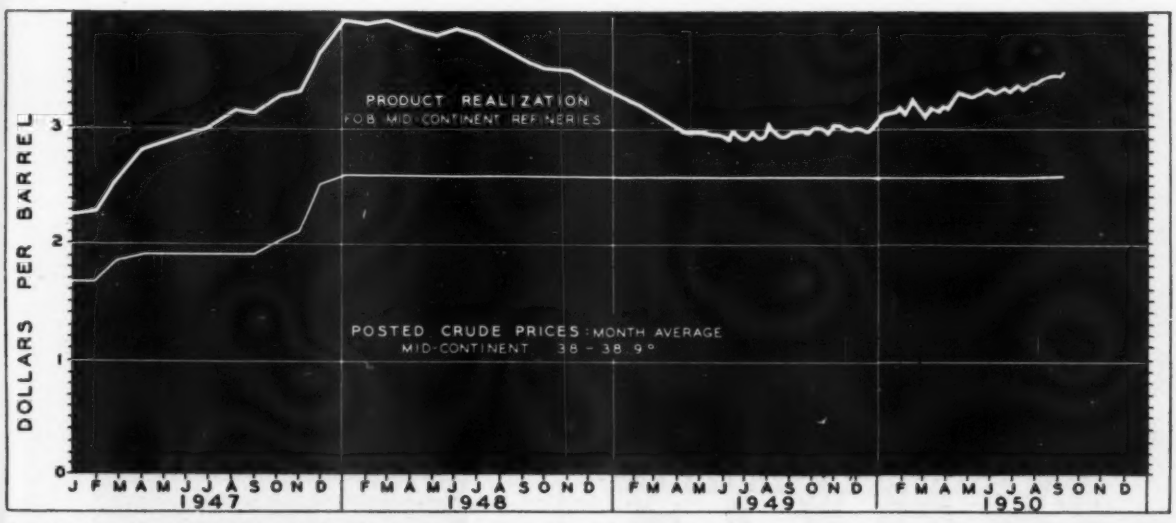
Western Pennsylvania

145-155 vis., 10 p.t. bright stock	28
180 vis., 0 p.t. neutral	29

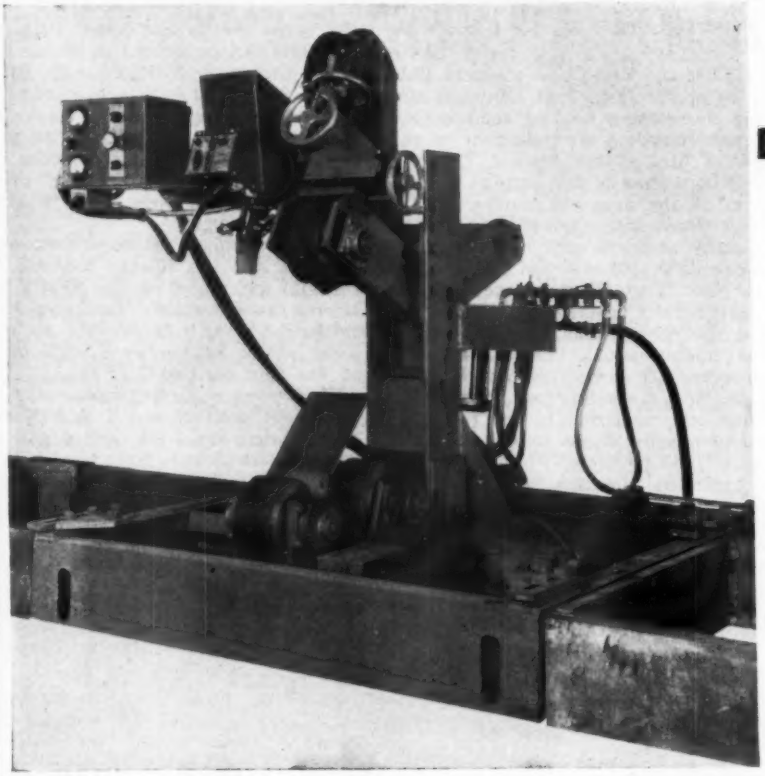
WAX

Mid-Continent

132-134 A.M.P.	5.0



In this trend chart refinery realization is based on average Mid-Continent grade crude oil (not 38° gravity only) and average prices for refinery products as published in The Oil and Gas Journal basis Oklahoma (Group 3). Refinery yields confined to gasoline, kerosine, distillate, and fuel oil. Realization averaged $3.50 for week ended September 9, $3.47 for previous week, and $2.99 for September 1949.



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in the field.

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WELDING EQUIPMENT CO.

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The DAVIS No. 330W Field Regulator

1. SIMPLE, DEPENDABLE, AUTOMATIC! Widely used in gas-gathering systems everywhere, indoors or outdoors. Exclusive rain cap protects diaphragm.
2. VERSATILE! Use for either back pressure or vacuum merely by reversing counterweight—no extra parts to add.
3. SENSITIVE! Thanks to large diaphragm, weight loading, balanced valve. Built-in by-pass steadies action, prevents pulsation.
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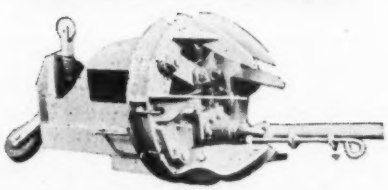

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EQUIPMENT MEN ... in the News

Borden, Austin Made Kaiser Steel Vice Presidents

C. F. BORDEN

ATWOOD AUSTIN

Appointments of two new vice presidents of Kaiser Steel Corp. have been announced by Jack L. Ashby, vice president and general manager. The new officers are C. F. Borden, general sales manager of Kaiser Steel since 1947, who was named vice president in charge of sales, and Atwood Austin, financial consultant for several of the Kaiser companies, who was appointed vice president and treasurer of the steel firm.

Borden, who is well known in the steel industry in the West, has been in steel sales most of his business career. He was with Columbia Steel and Geneva Steel Corp. before coming to Kaiser Steel in 1945. He is a graduate of University of Washington and the graduate school of business at Stanford University.

A graduate of Ohio State University, Austin served in management capacities with manufacturing firms in Pittsburgh and Detroit before joining the Kaiser organization in 1946 as a financial consultant to the executive vice president.

Bruckner Elected to New Maloney-Crawford Position

Frank L. Bruckner has been elected vice president and secretary of Maloney-Crawford Tank & Manufacturing Co. of Tulsa, according to an announcement by S. P. Wallace, president.

Bruckner, who has been connected with the petroleum industry since 1926, takes the position of J. C. Highfill who retired August 1.

Caldwell Named President Of Harrisburg Sales Firm

Charles B. Caldwell, formerly special sales representative in the Dallas area with Hughes Tool Co., has been named president of Harrisburg Sales & Service, Inc., Houston.

Caldwell joined Hughes Tool in 1937 and since that time has served in the capacities of field salesman at Hays, Kans., Oklahoma City, and Ardmore, Okla., and as special sales representative in Oklahoma City and Dallas.

Syverson Named ICI Service Rocky Mountain Manager

E. M. SYVERSON

R. J. (Bob) Harcus, vice president and general manager of International Cementers, Inc., has announced the recent appointment of Edward M. Syverson as division manager of ICI service's Rocky Mountain division.

Syverson, who has been with ICI service for a number of years, directs the division operation from headquarters at Casper, Wyo.

Magnaflux Moves to New Dallas Headquarters

Magnaflux Corp. has moved into its new office at 2823 Manor Way, Dallas, after its previous office and shop was destroyed by an aircraft crash in Dallas last November. A complete office serving the entire Southwest has now been set up.

Magnaflux inspection is one of several nondestructvie testing methods used and sold by Magnaflux Corp. for inspection of parts during manufacture or overhaul to insure that the parts are free from discontinuities which might cause failure. Magnaflux is also equipped to handle work in the field, having several trucks and trained crews for this work.

Included in this new Magnaflux building is an inspection laboratory where local inspection work can be done.

Livingston to Manage McKee's Refining Sales

Arthur G. McKee & Co., Cleveland, engineers and contractors in the petroleum refining and iron and steel industries, announce that Myron J. Livingston has been appointed to the position of sales manager of the company's petroleum - refining division. He will be located at headquarters in Cleveland.

For the past 6 years, Livingston has been in charge of the firm's sales office in New York. Jerry Brennan, who recently became associated with the company as a sales engineer, will be placed in charge of the New York office. Brennan formerly had been the New York representative of Sivyer Steel Castings Co.

Coonley Named Manager of A.C.F.'s Valve Division

J. C. COONLEY

John C. Coonley has been appointed manager of American Car & Foundry Co.'s valve division, it has been announced by the president of the company, Charles J. Hardy, Jr.

Coonley succeeds W. R. Kottsieper, who is retiring after more than 44 years of service with A.C.F. He will continue to make his headquarters in Detroit where A.C.F. valves are manufactured.

Coonley brings to A.C.F. a wealth of experience in valve and machine tool design. He was with Walworth Co. as salesman, engineer, and tool-design superintendent for many years prior to coming to A.C.F. in June of this year as assistant manager of the valve division.

Canadian National Supply Opens Redwater Store

National Supply Co., Ltd., has announced the opening of a new store at Redwater, Alta., Canada. The store is being opened to provide better service for operations in Redwater field, according to R. Wesley Burns, National Supply's Canadian division manager.

Redwater field has, at present, about 600 producing wells with about half this number additional expected in the near future.

National Supply's Redwater store will stock a complete line of produc-

tion equipment as well as valves, fittings, and miscellaneous supplies needed. The store will have a fully equipped, modern pump shop for repairing and servicing Fluid Packed Pump Co.'s down-well pumps and all other types of down-well pumps. A complete line of expendable parts for rotary-drilling rigs operating in the vicinity will be stocked.

Adams Named as Assistant To Bowser Board Chairman

Joseph F. Adams has been appointed to fill the newly created position of assistant to the chairman of the board of directors of Bowser, Inc. The appointment has been confirmed by R. Hosken Damon, Bowser board chairman.

Adams was formerly vice president in charge of marketing of Barnsdall Refining Co., Tulsa. His new headquarters are at the Bowser, Inc., executive offices, Chicago, where he has undertaken a continuing study of petroleum-marketing problems as they affect Bowser operations.

Marley Makes Maze Manager Of Merchandising Sales

ROY W. MAZE

Promotion of Roy W. Maze to the position of merchandising sales manager of Marley Co., Inc., has been announced by L. A. Christensen, general sales manager. Maze received his A.B. degree from the College of Emporia and an M.S. from Kansas State College. Following college, he spent 5 years teaching and in administrative work in high schools. In 1942 he joined the engineering department of Aireon Corp. In 1946, Maze joined Marley as public-relations director, the position he held until his recent promotion.

Dowell District Manager Transfers to Brazos

O. W. LYONS

FLOYD CARR

Orlin W. Lyons, district manager for Dowell Incorporated at Shreveport, La., for the past 7 years, has accepted a position on the management staff of Brazos Oil & Gas Co. and will be located at Houston.

Brazos is a wholly owned subsidiary of Dow Chemical Co. with operations in Texas, California, and Michigan. Dowell is also a wholly owned subsidiary of Dow, specializing in the application of chemical services to the petroleum industry. Floyd Carr, now development engineer for Dowell Perfo-Jet Services in the Tulsa general offices, has been appointed district manager at Shreveport to succeed Lyons.

Lyons has been with Dowell since August 1936, when he was employed as a student treating engineer at Newton, Kans.

Carr, who originally was employed by Dowell as a student treater in Flora, Ill., in 1939, has been Perfo-Jet development engineer in Tulsa since February 1949.

Rubel Elected a Director Of Lane-Wells Co.

A. C. (Cy) Rubel, prominent oil man and vice president in charge of exploration and production of Union Oil Co., has been elected a director of Lane-Wells Co., according to an announcement by Walter T. Wells, chairman.

Rubel, who is also a director and a member of the executive committee of Union Oil Co., started work with that company in 1923 as an exploration geologist. Then he served as petroleum engineer, field superintendent, division superintendent, and manager of exploration, before reaching his present position. He received his degree in mining engineering and metallurgy from University of Arizona.

Oilwell Supply Names New Store Managers

The appointment of two store managers in Oil Well Supply Co.'s central midwest division have been announced by V. J. Waters, division manager, and F. D. Smith, division manager, Gulf Coast division, announced three personnel changes.

Ralph Crowe, manager of the Greggton, Tex., store since March 1948, has been named manager of the Snyder, Tex., store, succeeding Wayne B. Atkins, who will devote his time to sales promotion in the Snyder area. Crowe is succeeded at Greggton by G. D. Fisher, who had been field representative at that location for the past 2 years.

Chester L. Vines has been named manager of Oilwell's Mission, Tex., store and is succeeded as field representative at Rockport, Tex., by Otto W. Green, formerly field representative at Pettus, Tex. James W. Andrews has been named district specialty representative for the division's southeast Texas district, with headquarters at Beaumont, Tex.

Crowe was employed by Oilwell in 1944 as warehouseman in Anson, Tex., and became store manager in 1945. Fisher joined the company as storeman in Greggton in 1946 and was promoted to field representative in 1948. Vines has been connected with Oilwell since 1948. He first served as storeman in Alice, Tex., and in 1949 was made field representative at Rockport. Green joined the company in 1949 as warehouseman in the Pettus store and became field representative in that area in April this year. Andrews has served the firm as field representative at New Iberia, La., since July 1949. He also held earlier positions as field engineer at Houston and Jennings, La.

Gibbons Adds Six Franks Well Servicing Units

In preparation for increased demand, J. P. (Bum) Gibbons of Midland, Tex., has recently added six new well servicing units, four of which are shown, to his already large fleet. The identical units are made by Franks Manufacturing Corp. of Tulsa.

Quaker to Construct New Furfural Plant at Omaha

Quaker Oats Co. plans to start immediate construction of a chemical plant in Omaha. The new plant will produce the versatile chemical, furfural, and will be similar to the Quaker plant located at Memphis which was purchased for approximately $1,500,000 in 1946. The plant will be on 5 acres located just south of the Jones Street power plant and backing up to the Union Pacific embankment to the river bridge, and should be completed and in produc-

(Continued on page 420)

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WELL equipment. New and used spudders, rotaries, core drills, all sizes and types. Cable tools, drill pipe, bits, pipe. Fishing tools rented. Everything for well service. Pressey & Son, Pueblo, Colo.

FOR SALE: 300 Amp Westinghouse welding machine powered by 6-BK Waukesha engine. Completely overhauled. Less than 50% of new price. Melton Supply Company, Box 1360, Seminole, Oklahoma.

IDECO complete oil rig on sixteen wheel trailer for sale or lease. Terms. Tel.: Orchard 13514 or write E. D. Warren, 302 East Queen Street, Inglewood, Calif.

FOR SALE: New 100 ton Hydraulic, pipe, tube and shape bending press. $5000 FOB Astoria, Oregon. Orval Eaton, City Hall, Astoria, Oregon.

BARGAIN FOR QUICK SALE

Large Steam Rig Complete Ready to go. 14x14 Engine, 18" & 20" Pumps, 10,000' 4½ Drill Pipe, 136' Drk All 300 Ton Equipment. Everything Good Condition. **McDaniel & Beecherl Drlg. Co.,** 521 Republic Bank Bldg., Dallas, Texas, or Phone 3651, Odessa, Texas.

FOR SALE

9—230 H.P. Bessemer Type 10 Engines with compressors, Steel Buildings, Valves and Fittings complete for installation. Located Salem, Illinois Oilfield.

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EQUIPMENT FOR SALE

2 New Hydraulic Shot Hole Drill Rigs at Special Price. Capacity, 400' of 3" hole with 2⅜" drill pipe comprising 1½ ton Ford truck, 25' 6" tubular mast with double acting hydraulic rams to provide 10' continuous non-chucking stroke, hydraulic operated winch, hydraulic powered rotary table, hydraulic rotary table push down, G-D 4 x 5 mud pump, swivel, 49 sections of 2⅜" drill pipe 10' long and complete accessory equipment.
Write or call:
C. R. ATHY, c/o International Derrick & Equipment Co., Atlantic Bldg., Dallas. telephone RI-1031

8" PIPE FOR SALE

Approximately 800 miles of 8"—29.02# line pipe being taken up. This pipe was used in a 650# Pressure Products Line. Pipe Subject to Prior Sale F.O.B. Pittsburgh District.

Wire or Write if interested
Box 574, Tulsa, Oklahoma

EQUIPMENT FOR SALE

FOR SALE: 10—10,000 gal. cap. ⅜-in. Shell ½ in. Heads Clean Horiz. Steel Storage Tanks f.o.b. Pittsburgh. Lestan Corp., Rosemont, Pa.

FOR SALE: Failing 5500 portable drilling rig mounted on K-8 International truck. Fully equipped with all hand tools, 1100' 3" Acme thread, drill stem, dog house, 1949 Fifth wheel truck (Chev.), 1942 Dodge water truck, pipe trailer. Equipment in good condition. Write Philip Lindsley, Jr., 4428 Stanford St., Dallas, Texas, or call FO-88159.

FOR SALE: 1942 Model Fort Worth Jumbo "C" Spudder in good repair and complete with tools. Skid type Advance Rumley pipe pulling unit capable of 4000' well servicing also in good condition. Large supply of cable tools also for sale. G. W. Hicks, Moline, Kansas.

FOR SALE

7500' 2" xx seamless pipe approx. 400' new 16" bell & spigot 150# cast iron pipe—at mill price.

BOX 574, Tulsa, Oklahoma.

Several Army Surplus 4½" x 6" Gaso Duplex 1860 Pumps—two piece skid mounted with Chrysler 8 cylinder engines. Will sell pumps only or complete units about half price.

H. H. COFFIELD
ATTN: W. H. Orr
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A-86084—Houston, Texas

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USED ROTARY AND CABLE TOOL DRILLING TOOLS, WIRE LINES. E. A. KELLY, BOX 851, OKLAHOMA CITY. PHONE 5-6407.

1—36-L Bucyrus Erie Drilling Machine. 1—24-L, also 1—Keystone No. 80. These machines are practically new and can be inspected on drilling site. Contact R. F. McMahan, Taylor 7253 or Taylor 4116, Louisville, Kentucky.

FOR SALE: 2—36-L Bucyrus Erie Spudders complete with cable tools. THE SANDY SUPPLY COMPANY, WOOSTER, OHIO.

FOR SALE

Hydraulic Casing Pulling Units, Hydraulic Jacks, Casing Spiders, Rings & Slips. Also,
Skid Mounted Cementing Unit, Complete.
Write or Call

OKLAHOMA MACHINE & SUPPLY CO.
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FOR SALE

1000 ft. of 3" upset tubing. Like new. 80c per ft.

4000 ft. 2⅜" range 1 drill stem. Hughes Acme tool joints. Like new. $1.50 per ft.

1550 gal. Army Air Force tank and trailer—new. $750.

Four 700 gal. glass insulated skid-mounted tanks. $300. Perfect for winter work in Wyoming and Kansas.

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Box 136, Princeton, Ind.

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125,000' 4" OD x .160" Wall Seamless 6.5# Good Used Light Weight Line Pipe to be taken up in 30' to 40' Lengths, FOB Cars near Borger, Texas.

900,000' 6⅝" OD x .280" Wall 18.97# Used Lapweld Standard Line Pipe, Machine Cleaned, Torch Beveled Ends 30°, 20' Random Lengths, 90% Excellent No. 1 Grade, 10% Good No. 2 Grade, FOB Ohio. Material available for inspection and immediate shipment.

100,000' 8⅝" OD 28# Used Lapweld Line Pipe, Reported as Good No. 2 Grade, Uncleaned, Untrimmed Ends, FOB Pennsylvania.

17,000' 10¾" OD x .312" Wall 34# Used Lapweld Line Pipe, Double Random Lengths, Uncleaned, Torch Cut Ends, FOB Ohio.

22,000' SAME AS ABOVE, except 20' Lengths with smooth Plain Ends. This portion of the line was joined by Dressler Couplings FOB Ohio.

2,320' 18" OD x .312" Wall 59.03# New Black E.W. 39'-40' Lengths.

2,480' 20" OD x .344" Wall 72.16# New Black E.W. 18'-40' Lengths.

3,250' 20" OD x .312" Wall 65.70# New Black E.W. 35'-40' Lengths.

2,760' 24" OD x .312" Wall 79.05# New Black E.W. 39'-40' Lengths.

4,000' 26" OD x .260./300" Wall 75.82# New Black E.W. 39'-40' Lengths.

NEW AND GOOD USED SEAMLESS AND LAPWELD CASING AND TUBING AVAILABLE IN ALL DESIRABLE SIZES FOR IMMEDIATE DELIVERY, SUBJECT TO PRIOR SALE. WIRE OR PHONE COLLECT, SIDNEY 1791, FOR PRICES—ACT NOW!!!

A. J. STRUBEL
Sidney 1791 . . . 4946 Murdoch, St. Louis, Mo.

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EQUIPMENT FOR SALE

FOR SALE: Long wheelbase heavy duty tandem truck driven 12,000 miles. Ideal for drilling rig or heavy workover unit. Fred R. Holland, 7403 Bankhead Highway, Fort Worth, Texas.

3000′ of 5½″ OD 20# 8 Rd. Thread, Range 2, seamless casing with J-55 couplings. 3300′ of 4″ OD Pittsburgh seamless, Range 2 drill pipe with Hughes Flash weld full hole tool joints. Pipe in excellent shape, having drilled only 40,000 ft. hole. Contact Box 1517, Phone 3957, Pampa, Texas.

NATIONAL "50" Compound Double Drum Rig 126′ Cantilever L. C. Moore Mast 10′ substructure. 6,000′ 4″ drill pipe. This rig complete and in excellent condition. P. O. Box 205, Sta. B, Bakersfield, California.

DRILL PIPE

10,000 ft. 3½″ OD used seamless, weighing approx. 13# per foot, with tool joints.

USED SEAMLESS STEEL TUBING
Plain End Beveled for Welding

75,000 ft. 2¼″ OD, approx. 2.90# per ft.
25,000 ft. 3½″ OD, approx. 5# per ft.
25,000 ft. 4″ OD, approx. 6# per ft.
25,000 ft. 5½″ OD, approx. 9# per ft.

All reconditioned, hydrostatically tested to 850# pressure.

• • • • • •

18,000 ft. 6″ OD used electric welded steel pipe, approx. ⅛″ wall, 24′ lengths.

• • • • • •

All material guaranteed in first-class condition. All ready for IMMEDIATE SHIPMENT.

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New and Guaranteed Used STEEL TANKS, Riveted, welded and bolted, in all capacities; also WOOD TANKS.

A. GREENSPON PIPE CO., INC.
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SPECIAL OFFERING

12′ Fractionating Columns

TOWERS—A-1 Condition
Immediate Delivery

One Stripper Column—12′ I.D. x 66′ tangent to tangent x ¾″ thick shell and heads, ASME-API code constructed stress relieved and radiographed, 29 Carbon Steel trays and caps on 2′ spacing, 100# @ 200° F., mounted on 12′ I.D. x 9′4″ high x ⅜″ thick skirt.

Two Extractor Columns, 12′6″ I.D. x 85′5″ tangent to tangent x 1″ thick shell x ⅝″ thick hemispherical heads, 40 Carbon Steel trays on 2′ spacing, 150# @ 300° F., radiographed, mounted on 12′6″ I.D. x 16′7″ high skirt.

Write, Wire, Phone for Listings

DULIEN STEEL PRODUCTS, INC.
of Washington
P. O. BOX 667
COTTON VALLEY, LA.
PHONE: COTTON VALLEY 26

EQUIPMENT FOR SALE

FOR SALE: One Wilson super draw works, used on small rotary. Has break-out cathead and friction clutch for rotary table; two Buda FRH motors—all for $1650.00. Two 100 bbl. bolted tanks, complete with steel walks—$500.00. Or WILL TRADE the above items for 3000′ well servicing unit, equipped with spudder arm. Graves Drilling Co., 805 West Main, Marietta, Okla. Phone 480.

WAR SURPLUS MACHINERY
Gaso, Byron Jackson, Aurora, Wayne, Lombard & Hale Fire Pumps with Engines, 1½ to 25 KW Generator Sets or Light Plants, Engines, Suction Hose, Fire Hose, Victaulic Couplings & Etc. Write for listing. H. A. McCarthy, 310 Thompson Bldg., Phone 5-3296, Tulsa, Oklahoma.

6,218 FEET 7″ O.D. 17# new seamless casing H-40 Rg 2 @ 2.90 ft. Phone 5-8850, Tulsa.

RECONDITIONED money-saving Franks SA-4500 Rotary Drilling Rig equipped with 96-foot derrick and rotary table. Write: Box D-681, The Oil and Gas Journal, Tulsa, Oklahoma.

200,000 LBS. OF FOAMITE

Mfg. by Pyrene Co. . Excellent condition. Field lab tested. Sealed in original tin carton. Wgt. 47 lbs. per can.

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29 East 7th South, Salt Lake City, Utah
Ph. 9-9632

STANDARD BLACK PIPE

GOOD USED CONDITION
Immediate Delivery

2 inch—40,000 feet.
3 inch—35,000 feet.
4 inch—55,000 feet.
6 inch—5,000 feet.
8 inch—8,000 feet.
10 inch—1,500 feet.
12 inch—1,500 feet.

Subject to Prior Sale.

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THatcher 9243

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Immediate Delivery

C. F. R. — A. S. T. M.
OCTANE ENGINE

complete with all accessories.

Price $4,250

May be inspected at
408 No. Boston Ave., Tulsa, Okla.

Write, wire or phone

Sidney Born

2-2186, Tulsa, Oklahoma.

EQUIPMENT FOR SALE

FOR SALE: Set of 12½ bits and stem and other tools. Albert Breisach, Paola, Kansas.

CASING, TUBING, LINE PIPE FOR SALE: Good used lap weld 2″ to 10¾″. Reasonable prices. Everything in cable drilling tools, rigs, belts, drilling engines, surplus wire lines. TRI STATE TOOL AND SUPPLY CO., Box 827, Parkersburg, W. Va. Phone 7-5121.

FOR SALE

4—Fairbanks-Morse ZC-346 Pumping Engines complete with Type J Clutch and Sheaves. Two Units practically new and all in good running condition — Price $3750 for four engines or $1000 each. Available for inspection—Lamesa, Texas. Write, wire or call: **McMillian and Peterson, P. O. Box 1787, Phone 1471, Midland, Texas.**

FOR SALE

9—Type K New Double Reduction Pumping Units suitable for 1000′ wells with 2″ tubing. Price $375.00 each, less counter weights, foundation bolts and motor. FOB shop.

OKLAHOMA MACHINE & SUPPLY CO.
P.O. Box 997, Ada, Okla. Tele. 780

PIPE FOR SALE

5565′ 3½″ OD, 13.30# National Seamless Grade "D" API internal upset drill pipe, range 2 lengths, with Reed super shrink grip full hole tool joints (4⅝″ OD x 2 7/16″ ID) attached. This is new material in railroad storage at New York, originally destined for export. Will sell at mill carload price with freight allowance. Write or wire

J. H. McCORMICK
3023 RCA Building
30 Rockefeller Plaza, New York 20, N. Y.

New Seamless Line Pipe

(AVAILABLE DELIVERY SOON)

50,000′ 10¾″ O.D. x .250 wall
60,000′ 12¾″ O.D. x .281 wall

All Seamless A.P.I. Grade B 5LX42, 30 to 40 ft. DRL, Plain Ends beveled. Delivery Houston, Tex., about October 5th. Price available on request.

Mid-States Pipe & Supply Co.
Ph. 2-9128 **Tulsa, Okla.**

EQUIPMENT WANTED

WANT two modern type gas engines, 40 to 80 hp. range. Generator or gas powered generator set. 220 or 440 a.c. in 20 to 60 kw. range. Condition, location, and price, please. Williams Oil Co., 915 South Main, Ottawa, Kansas.

WANTED TO BUY: All steel spudder of 2000 to 4000 foot capacity, with or without tools. Give cash price and location. Donald McCort, Atlas Star Route, Barnesville, Ohio.

WANTED: L.P.G. Code Tanks 150 to 400 bbl. capacity. Wood River Oil & Refining Co., Inc., 321 W. Douglas, Wichita, Kansas, Telephone 5-5674.

WANTED!

Pipe Threading Machines
6", 8" and 12"

Landis or Bignall & Keeler with Landis Heads. Machines must be in good working order with individual motor drives. Give complete description including make, model and serial numbers, width of dies or chasers, motor specifications and prices.

CENTRALIA PIPE & SUPPLY CO.
Box 454—Tele. 6771
Centralia, Illinois

EQUIPMENT WANTED

WANTED TO BUY: 16" O.D. and 10" O.D. 8 or 10 thd. 13⅜" and 9⅝" 8 thread collars, new or used. Box 574, Tulsa, Okla.

WANTED: USED 4½" DRILL PIPE
Box D-606, The Oil and Gas Journal, Tulsa, Oklahoma.

WANTED: 28 or 36-L with casing strut or similar machine without tools. Must be in good shape and reasonable. Ralph Stubble, Chatham, Ontario.

WANT several wood tanks suitable for water separators. Prefer 12′ to 18′ height. Write: Williams Oil Co., 915 South Main, Ottawa, Kansas.

HELP WANTED

PETROLEUM Engineer or Geologist with experience in evaluation and subsurface studies in Gulf Coast wanted by sound independent. Age 30-45. In application state salary expected and enclose college transcript. Box D-631, The Oil and Gas Journal, Tulsa, Oklahoma.

LAND MAN for large producing company. Must be well rounded with several years experience. Replies will be confidential. Box D-683, The Oil and Gas Journal, Tulsa, Oklahoma.

FOREIGN and Domestic Oil Employment Directory covering the oil industry, showing where to apply for jobs. Price $5.00. Oil Industry Mailing List, Box 2603, Tulsa, Okla.

DRAFTSMEN

Positions open for draftsmen experienced in general refinery drafting, pressure vessel design, piping layout, etc. Give education, experience, and salary expected.

KOCH ENGINEERING CO., INC.
335 West Lewis Street
Wichita, Kansas

SALES ENGINEERS
OPERATIONS SUPERVISORS
PERFORATOR OPERATORS

Only Experienced Men Need Apply

WRITE ONLY

WELEX JET SERVICES, INC.
3909 Hemphill Street, Fort Worth 9, Tex.

Instrument Repairman, First Class to work in Celanese Chemical Plant in the Corpus Christi, Texas, area. Permanent job at $2.10 per hour. Must be capable of repairing, overhauling, installing, and doing general trouble shooting on all types of Automatic Control Systems; such as Taylor, Foxboro, Brown, Leeds-Northrup, Fisher, and Westcotts. Must be acquainted with the general operations of towers, furnaces, boiler equipment, and be qualified to work from Engineering Blue Prints and Specifications.

In letter, applicant should give his complete work history with description of duties performed, equipment worked on, physical description, age, and number of dependents.

Address replies to
CELANESE CORPORATION OF AMERICA
Attention: Employment Manager, P. O. Box 148, Bishop, Texas

ESTIMATOR

Experienced ENGINEER familiar with Oil Refinery design and capable of estimating process equipment from flow diagrams.

Give full information, experience record and salary expected.

ARTHUR G. McKEE & CO.
2300 CHESTER AVE.
CLEVELAND 1, OHIO

HELP WANTED

ASSISTANT PIPELINE SUP'T.

An American oil company operating in South America requires on its regular staff a man thoroughly experienced in all phases of White Products Pipeline operations.

Write giving age, marital status, education, and details of experience. Communications will be held in strict confidence.

Box 308-K
Radio City Station
New York 19, New York

Maintenance Mechanic, First Class for Maintenance Repair, overhaul, and trouble shooting on 400 to 1,000 H.P. 2 and 4-cycle Clark, Worthington, Ingersoll-Rand, Steam and Gas Engines, Turbines, Pumps, Gear Boxes and Reduction Gears. In Celanese Chemical Plant in the Corpus Christi, Texas, area. Permanent job at a rate of $2.10 per hour. Experience desired. Selected applicant will be notified to report for personal interview and a physical examination.

In letter, applicant should give his complete work history with description of duties performed, equipment worked on, physical description, age, and number of dependents.

Address replies to
CELANESE CORPORATION OF AMERICA
Attention: Employment Manager, P. O. Box 148, Bishop, Texas

NEW SMALL OIL REFINERY IN BOLIVIA, S. A., REQUIRES EXPERIENCED PERSONNEL AS FOLLOWS FOR ONE YEAR WITH OPPORTUNITY RENEWAL CONTRACT. SALARIES PAID IN U. S. FUNDS:

CHIEF CHEMIST: Graduate chemical engineer minimum three to five years' refinery experience including control laboratory work and technical service in plant operations especially light ends and aviation gasoline blending.

CHIEF OPERATOR: Minimum five years' all-round refinery experience particularly with precise fractionation including operating foreman experience; capable directing refinery utility services. Graduate chemical engineer preferred.

OPERATORS: Experienced shift operators capable supervising plant and utilities operations especially precise fractionation; general over-all refinery experience necessary.

OCTANE TESTER: Thoroughly experienced routine methods and maintenance on aviation gasoline knock-testing engine.

INSTRUMENT MAN: Thoroughly experienced capable assuming responsibility of instrument department.

Write: Box D-665
The Oil and Gas Journal,
Tulsa, Oklahoma

SITUATIONS WANTED

DRILLING Contractor operating in West Texas and New Mexico desires to contact small or medium-sized independent oil company who needs an operating manager. Personal interview desired. Twenty years experience in all phases of the oil industry. Address replies to Box D-644, The Oil and Gas Journal, Tulsa, Oklahoma.

HIGHLY CAPABLE contact man with good education, personality, and experience desires position with reputable drilling contractor or sales organization. Salary and commission. Well known in Mid-Continent area. Available on due notice. Address Box D-672, The Oil and Gas Journal, Tulsa, Oklahoma.

ATTENTION: Well established oil well drilling contractor desires to manage and supervise: Individuals', groups', small or medium-sized oil companies' drilling, production and operating problems in Central and Western Texas, and New Mexico. Personal interview by appointment is desired. Makin Drilling Company, Box No. 131, Ph. No. 131, Hobbs, New Mexico.

SITUATIONS WANTED

SALES MANAGER with 15 years experience in Technical Sales work, covering Texas, Oklahoma and Louisiana oil fields. Also a Mechanical Engineer, at present employed. Have a clientele of good distributors. Box D-680, The Oil and Gas Journal, Tulsa, Oklahoma.

PETROLEUM ENGINEER-PRODUCTION SUPERINTENDENT. Experienced drilling, production, and geology in Kansas and Rocky Mountains. Ten years superintendent sales and operations major technical service company. Three years production superintendent independent producer and refiner. Experienced supervision and administration complete drilling and producing programs with excellent record for maximum results at minimum cost. Box D-679, The Oil and Gas Journal, Tulsa, Oklahoma.

ATTENTION—OIL EXECUTIVES

Do you need an experienced, honest, sober and aggressive assistant to relieve you of many responsibilities. Texas University Graduate B.B.A. degree, additional courses in Geology and Petroleum Engineering. Draft exempt, age 38, married, 16 years broad experience in all phases of Oil Industry including planning, organization and direction of accounting, production, drilling, purchasing, and Geological Departments. Also experienced in refining, recycling, repressuring, joint venture operations, leasing and promoting drilling deals. Desires connection as assistant to owner of aggressive Independent Oil or Drilling Company with heavy responsibilities. Best of references as to character and ability. Prefer Texas location but will consider out of state. Available October 1st, Interview desired immediately. Salary $750.00 per month. Please contact Roy Garner, 2612 Fowler Street, Phone Franklin 1789, Dallas, Texas.

GRADUATE GEOLOGIST: Age 28, two degrees, three years' experience, major company, desires position in geological, scouting or land department of progressive company. Box D-675, The Oil and Gas Journal, Tulsa, Oklahoma.

LEGAL BLANKS

BURKHART LEGAL BLANKS since 1908 Oil-Gas (all states), Business, Real Estate, Legal Forms, Leases, Revised With Government Regulations, Commercial Printing, Catalog and Samples on request. Burkhart Printing & Stationery Company, 115 South Cincinnati, Tulsa, 3, Oklahoma.

WANTED

WANTED: SURPLUS Chemicals, Oils, Waxes, Solvents, Wastes and Residues of all kinds. Chemical Service Corporation, 98-06 Beaver St., New York 5, N. Y.

FOR SALE

FOR SALE: Spartan Manor Trailer Coach, like new. Traveled less than 200 miles. J. W. Tilton, 436 Mayo Bldg., 5-5639, Tulsa, Okla.

TITANIA GEMSTONES

Can supply the new sensationally beautiful synthetic titania gemstone "rainbow diamond," facet cut, showing greater brilliance than the diamond and at a small fraction the cost. Harder than amethyst. Christmas is coming.

C. C. BOAK—Tonopah, Nev.

FOR SALE—MAPS

WILDCAT ACTIVITY MAP

Covering West Texas
and New Mexico

PERMIAN BASIN

Showing all drilling wells
and new discoveries.

Published Monthly, $3.50 an Issue

MIDLAND MAP CORP.
Midland, Texas, 401 N. Big Spring
Tel. 3238

XUM

LEASE AND DRILLING BLOCKS

WATER FLOOD 400 acres potential 1100 ft. can be purchased after coring. Box D-670, The Oil and Gas Journal, Tulsa, Oklahoma.

FOR OIL OVERRIDE or sale: 500 acre block joins lease of new oil strike in Pickett County, Tenn., by Alvin C. York, Pall Mall, Tenn., and Bruce Jones, Pensacola, Fla. 15 to 20 bbl. well, 550 ft. first survey Brook oil. John A. Damron, Albany, Kentucky.

WANTED TO BUY: Small producing wells in Kansas. Reply to Box D-682, The Oil and Gas Journal, Tulsa, Oklahoma.

SHALLOW production, Allen County, Kentucky, 11 Pumping Wells—10 bbls. per day. 18 Wells to Recondition. Joseph Thomas, 50 Radnor Circle, Grosse Pointe Farms 30, Michigan.

THE following lease blocks: Two Thousand acres Arkansas; Thousand acres Breckinridge, Kentucky; 200 acres Richland County, Illinois; 300 acres Wayne County, Illinois; 200 acres White County; 180 acres Gallatin County. Curtis Matz, Carmi, Illinois.

DEALERS INVESTORS: Acreage ahead of Drilling, Wildcat to Production. One of my Investors closed a $10,000 Deal Cost $500 now buying cheaper acreage. Active, Stands Investigation for Profits. New Fields and Pipelines. E. M. Adams, Marshall, Texas.

300 A. OHIO with oil wells at 700' steady income. Water flooding increases production, low cost. Allegany Dev. Co., Allegany, N. Y.

LEASES ROYALTIES

Producing and Nonproducing
Bought and Sold—Any Area
Inquiries Invited

B. D. BUCKLEY
6635 Delmar Ave., St. Louis 5, Mo.

ALBERTA
Leases and Royalties
ALBERTA LEASEHOLDS
131-Ninth Avenue West
Calgary, Alberta, Canada

DRILLING MONEY

For test well, offset, or participating interest. Prefer an offset interest. We have revolving funds for good plays. If you have deals that are satisfactory to our Geologist and you can prove that you are an experienced drilling operator with a reputation, you will be stepping into a real drilling program opportunity. Answer in confidence:

Box D-684

The Oil and Gas Journal,
Tulsa, Oklahoma

PATENT ATTORNEYS

PATENT Practice before U. S. Patent Office. Validity and Infringement Investigations and Opinions. Booklet and form "Evidence of Conception" forwarded upon request. Lancaster, Allwine & Rommell, Registered Patent Attorney, Suite 418, 815-15th Street, N.W., Washington 5, D. C.

MANUFACTURERS REPRESENTATIVE

MANUFACTURERS Representative covering Major Oil Companies New York Area seeks additional line, Centrifugal Pumps, Oil Field Engines or Electric Motors. Maintains Office, Warehouse and Shop. Box D-CL, The Oil and Gas Journal, 415 Lexington Avenue, New York.

ROYALTIES

DEEDED ROYALTIES
San Juan Basin & Permian Basin. Write Harry S. Wright, Wright Bldg., Farmington, New Mexico.

WANTED
PRODUCING ROYALTIES
BOX 591, HOUSTON, TEXAS

WE will buy producing or non-producing oil royalties. Standard Security Company, 115 Broadway, New York 6.

MONTANA ROYALTIES
Millions of acres now leased by world's major companies, with huge drilling play in prospect. For booklet describing Montana geology and oil development, write Landowners Royalty Company, Box 1225, Great Falls, Montana.

FOR SALE OR TRADE:

ROYALTY ON MAJOR COMPANY SEISMOGRAPH HIGH, 1/64th of 10,000 acres overriding royalty leased to Amerada Petroleum Corp. Located on Nesson Anticline in Williams and Mountrail Counties, North Dakota. Amerada has announced well to commence immediately. 1,250 acres overriding royalty available. Minimum purchase, 100 acres. Write, wire or call

M. B. RUDMAN
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Phone R-6159

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Complete information on oil and gas possibilities in Nevada. Up-to-date lease maps.
Filing service. Daily and weekly filing and development information. Experienced geological consultants.
UNITED ENGINEERS
252 West 1st St., Rm. 3, Reno, Nevada
Phone 26394

EQUIPMENT MEN

(Continued from page 416)

tion by 1951. The operation will employ about 100 people.

Principal uses of furfural include the manufacturing of nylon, refining of lubricating oils, manufacturing of synthetic resins, processing of diesel fuel, and the refining of butadiene for the production of synthetic rubber. Furfural is used commercially in over 50 industrial processes and products.

Denton Made Weston Advertising Manager

Earl R. Mellen, president of Weston Electrical Instrument Corp., Newark, N. J., has announced the appointment of Charles B. Denton as advertising manager.

Denton joined the Weston organization in 1925 and was associated with the company's advertising and sales-promotional activities until 1942. During World War II he directed the activities of Weston's labor-management war-production-drive committee and functioned as public-relations manager.

Union Carbide Elects W. H. Winans Vice President

W. H. WINANS

W. H. Winans has been elected vice president in charge of industrial relations, Union Carbide & Carbon Corp., it has been announced by F. H. Haggerson, president. Winans has been engaged in industrial relations activities since he joined the National Carbon Division of the corporation in Cleveland in 1916. He was appointed industrial relations manager of the parent organization in 1919.

Nation-Wide Forum Series To Help Santa Fe Research

Santa Fe Tank & Tower Co. has just initiated a series of nation-wide engineering forums to acquaint practically all phases of American industry with the latest concepts of cooling-tower design, construction, and operation. From a research standpoint, Santa Fe is able to obtain various reactions and suggestions to specific engineering problems. The first of these forums was conducted at Denver by Dr. N. W. Snyder, consulting engineer for Santa Fe Tank & Tower. Approximately 50 oil, power, and chemical engineers attended this meeting. Dr. Snyder outlined the critical factors involved in cooling-tower operation and an informal discussion followed. Another forum, this one at the Biltmore Hotel in Los Angeles, followed. Peter Phelps, Santa Fe engineer, was the principal speaker. His discussion dealt with design factors and their application to cooling-tower performance. Similar meetings, scheduled for the remainder of this year, will be held in San Francisco, Tulsa, Houston, Dallas, El Paso, Phoenix, and Chicago.

Three Get New Positions With United Supply

Three United Supply & Manufacturing Co. executives in the West Texas area have been appointed to new positions, it was announced by H. B. Gutelius, president.

John L. Smith has been named division manager of the West Texas area. Smith was promoted from his former job as district manager. His headquarters will be in Midland.

New district manager of the southern area of West Texas is Roger Northup with headquarters in Midland. Northup was formerly assistant district manager.

West Texas northern area district manager is now L. W. Moore whose headquarters will be in Hobbs, N. M.

XUM

Quaker Rubber Appoints General Sales Manager

H. M. SOSSAMAN

The appointment of Henry M. Sossaman as general sales manager of Quaker Rubber Corp., division of H. K. Porter Co., Inc., Philadelphia, has been announced by T. M. Evans, president. Sossaman's appointment to his new position culminates more than 22 years of service with Quaker Rubber Corp. Be began as a salesman in charge of the Florida sales district. Having been instrumental in the establishment of several Quaker branch offices, he was promoted to assistant general sales manager in 1943.

In his new position Sossaman will be in charge of sales of all products manufactured by Quaker Rubber Corp. These include conveyor and transmission belting, hose, packing and miscellaneous industrial rubber products for all industrial uses. Other promotions made within the organization are Charles E. Dugan, assistant general sales manager; Jack R. Lewis, assistant sales manager; Thomas L. Durkin, manager of contract sales; Art M. Lowrey, Philadelphia district sales manager; and Benjamin Shawcross, manager of moulded hose department.

Caterpillar Forms British Subsidiary

Announcement of the formation of Caterpillar Tractor Co., Ltd., a wholly owned British subsidiary, has been made by Louis B. Neumiller, president of Caterpillar Tractor Co., Peoria, Ill.

The new company will engage in the business of procuring, inspecting, storing, and shipping British-made Caterpillar parts to the company's dealers in United Kingdom and other countries.

Named to head the new English organization is Wallace J. Bornholdt, purchasing agent for Caterpillar, who will be managing director. He will be aided by Wayne H. Becker, parts control manager, who is to become merchandise manager of the subsidiary, and Wayne R. Thomson, planning staff engineer, selected to head up the technical and inspection department.

Named directors of the new concern are L. B. Neumiller, W. Blackie, E. W. Jackson, J. Q. McDonald, W. J. Bornholdt, all from Caterpillar Tractor Co., and R. E. Fearnley-Whittingstall, member of the British firm of legal counsel serving the new company. W. Blackie and E. W. Jackson have been elected chairman and vice chairman respectively of the board of directors of the subsidiary.

Petroleo Interamericano Offers Translation Service

Oscar B. Irizarry, director, Petroleo Interamericano, Latin-American magazine published by Petroleum Publishing Co., has announced that the translating staff is now equipped to handle outside translating jobs, large or small. Regular commercial rates will apply and prices can be quoted on receipt of material to be translated.

Over the last 6 years, Petroleo Interamericano's translating staff has built a technical nomenclature of petroleum terms which has contributed materially to standardizing the usage among oil countries of Latin America. The firm has published a 318-page glossary, and over 6,000 copies have been sold to oil firms throughout Latin America. Thus, the book has become the official manual for oil-company translating work.

Badger Joins Girdler

L. H. Badger, formerly chief estimator for Jones & Laughlin Supply Co., Engineering and Construction Division, Tulsa, has joined Girdler Corp., Louisville, as chief estimator in the gas processes division.

CALENDAR

September

American Society of Mechanical Engineers, fall meeting, Hotel Sheraton, Worcester, Mass., September 19-21.

American Society of Mechanical Engineers, petroleum mechanical engineering conference, Roosevelt Hotel, New Orleans, September 24-28.

Ohio Mineral Industries Conference, sponsored by Ohio State University and Ohio Department of Natural Resources, Ohio Museum Auditorium, Columbus, September 25-26.

American Petroleum Institute, executive committee of board of directors meeting, Broadmoor Hotel, Colorado Springs, Colo., September 26.

October

Independent Petroleum Association of America, annual membership meeting, Jefferson Hotel, St. Louis, October 2-3.

American Gas Association, annual convention, Atlantic City, N. J., October 2-6.

Mid-Continent Oil and Gas Association, Texas division, Dallas, October 4-5.

Petroleum Branch, American Institute of Mining and Metallurgical Engineers, Mid-Continent meeting, Roosevelt Hotel, New Orleans, October 4-6.

Liquefied Petroleum Gas Association, northeastern and southeastern districts joint meeting, Ambassador Hotel, Atlantic City, October 5-6.

American Association of Oilwell Drilling Contractors, annual meeting, Mayo Hotel, Tulsa, October 9-10

National Association of Corrosion Engineers, south-central regional meeting, Rice Hotel, Houston, October 9-10.

Instrumentation for Process Industries, fifth annual symposium, Texas A. & M. College, College Station, Tex., October 11-13.

Petroleum Branch, American Institute of Mining and Metallurgical Engineers, West Coast meeting, Elks Club, Los Angeles, October 12-13.

Western Petroleum Refiners Association, regional meeting, Gladstone Hotel, Casper, Wyo., October 12-13.

West Virginia Geological Survey, conference on secondary recovery of oil in West Virginia, Morgantown, W. Va., October 13-14.

Oil Progress Week, October 16-21.

National Safety Congress, Chicago, October 16-20. Petroleum Section, October 17.

American Association of Petroleum Geologists, Pacific Section, Ambassador Hotel, Los Angeles, October 19-20.

Society of Economic Paleontologists and Mineralogists, Pacific Coast Section, Ambassador Hotel, Los Angeles, October 19-20.

Society of Exploration Geophysicists, Ambassador Hotel, Los Angeles, October 19-20.

Permian Basin Oil Show, Odessa, Tex., October 19-22.

Independent Natural Gas Association of America, annual meeting, Shamrock Hotel, Houston, October 23.

National Lubricating Grease Institute, annual meeting, Edgewater Beach Hotel, Chicago, October 30-November 1.

November

Mid-Continent Oil and Gas Association, Louisiana-Arkansas Division, annual meeting, Roosevelt Hotel, New Orleans, November 2-3.

New Mexico Geological Society, first annual conference, San Juan Basin; headquarters, Albuquerque; November 3-5.

Society of Automotive Engineers, Fuels and Lubricants meeting, Mayo Hotel, Tulsa, November 9-10.

California Natural Gasoline Association, Silver Anniversary, Los Angeles, November 9-10.

American Petroleum Institute, annual meeting, Biltmore and Ambassador Hotels, Los Angeles, November 13-16.

American Society of Mechanical Engineers, annual meeting, Grand Central Palace, New York, November 27-December 1.

Southwestern Geophysical and Geological Conference, Hotel Texas, Fort Worth, November 30-December 2.

December

American Institute of Mining and Metallurgical Engineers, annual joint meeting, Texas sections, Texas Technological College, Lubbock, Tex., December 1-2.

American Institute of Chemical Engineers, annual meeting, Columbus, Ohio, December 3-6.

Interstate Oil Compact Commission, winter meeting, Shamrock Hotel, Houston, December 11-13.

NOMADS

Tulsa Nomads, third Friday of each month. After Five Room, Tulsa Hotel.

Dallas-Fort Worth Nomads, first Monday of each month. Greater Dallas Club.

Houston Nomads, second Monday of each month. Ye Ole College Inn, Houston.

Los Angeles Nomads, second Wednesday of each month. Jonathan Club.

New York Nomads, golf party, September 19, Knoll Golf Club, Boonton Manor, N. J.; dinner meetings, October 2 and November 6, Louis Sherry's; annual Christmas dance, December 9, Hotel Pierre.

LEGAL

Sealed bids for oil and gas mining leases on certain trust lands on the Crow Indian Reservation, Big Horn County, State of Montana, will be received at the Office of the Superintendent, Crow Indian Agency, Crow Agency, Montana, up to 2:00 o'clock P.M., M. S. T., October 6, 1950. For further information, call or write L. C. Lippert, Superintendent, Crow Indian Agency, Crow Agency, Montana.

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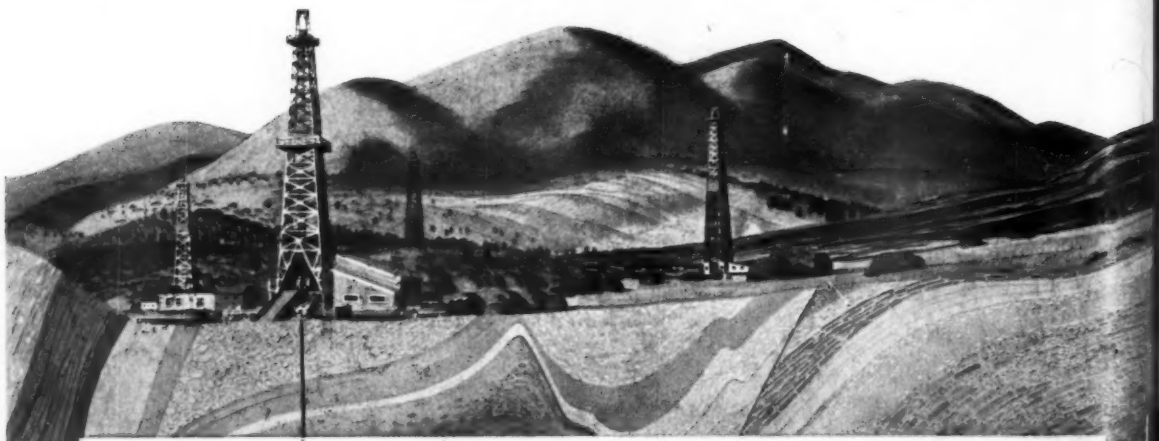

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